AN ANALYTICAL MODEL FOR ASSESSING THE KNOWLEDGE OF STATISTICAL PROCEDURES AMONGST POSTGRADUATE STUDENTS IN A HIGHER EDUCATIONAL ENVIRONMENT

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ABSTRACT

Over the past decades, the use and application of statistical concepts for university students have been a big challenge learned from their previous courses. Aftermath of democracy, South African higher education focused on redressing issues of reparation and social imbalances inherited from Apartheid with the commitment to reconstruct a comprehensive educational quality framework. Growing activities lead to new models emphasised to support students and universities in their attempts to demonstrate evidence of enthusiastic statistics learning, with an acceptable degree of accuracy. This study combines quantitative and qualitative research approaches to assess the knowledge of postgraduate students in applying suitable statistical procedures in higher education (HE). The quantitative data were randomly collected from the postgraduate students (n_1=307) while the qualitative data were collected through semi-structured interviews (n_2=19) from two institutions (University of Cape Town [UCT] and University of the Western Cape [UWC]) in the Western Cape, South Africa. The SPSS V24 statistical package was used for quantitative data analysis and the explorative design was selected as a theoretical framework to guide the investigation, analysis and interpretation of the qualitative findings. UCT model achieved for all combined categories 73% high prediction accuracy. The UWC model revealed similar results, with ask for help, worth of statistics, fear of statistics monitors, affect, cognitive competence, support from significant others, marital status, ethnic groups and type of study as significant predictors with a high prediction accuracy of 75.49%. Additionally, the ethnic groups, marital status, postgraduate programmes, experiences in statistics and effort were significant contributed factors of SELS beliefs while findings of the combined data of UCT and UWC significantly explained the variation observed in SELS beliefs with only 60% model accuracy.

Nevertheless, the qualitative data outcomes indicated that the comments of the participants provided a rich understanding of the perceived failure to choose a relevant statistical test. The results further indicated that confusion and frustration characterised the attitude of students during the selection of a suitable statistical test. The original value of this current study is bridging the inequity gap, in terms of statistics learning, and building a substantial input to the achievement of the objectives of UNESCO, the World Education Forum and the White Paper 3, while ultimately, contributing to the sustainable development of learning statistics at universities in the Western Cape, South Africa. By logical extrapolation, this current study proffers significant insights to the rest of the universities in Africa, and beyond.

KEYWORDS

Academic environment

Postgraduate research

Self-efficacy

Social support

Statistical procedures

LIST OF ACRONYMS AND ABBREVIATIONS

ABE	Adult Basic Education and Training
ANOVA	Analysis of Variances
ANC	African National Congress
ATS	Attitudes towards Statistics
BUs	Black Universities
CC	Complete Confidence
CCA	Canonical Correlation Analysis
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CI	Confidence Interval
COSATU	Congress of South African Trade Unions
Cog Comp	Cognitive Competence
CUMSA	Curriculum Model for South Africa
DDA	Descriptive Discriminant Analysis
DF	Degree of freedom
ET	Effective in service Training
ExpRmeth	Experiences in Research Methodology
ExpStats	Experiences in Statistics
FET	Further Education and Training
GET	General Education and Training
GPA	Grade Point Average
HEQC	Higher Educational Quality Council
HES	Higher Education System
HSRC	Human Sciences Resource Council
MANOVA	Multivariate Analysis of Variances
MBE	Ministry of Basic Education
MHET	Ministry of Higher Education and Training
MSPSS	Multidimensional Scale of Perceived Social Support
NCDC	National Curriculum Development Committee
NCHE	National Commission on Higher Education
NGOs	Non-Governmental Organisations
NLRD	National Learners' Records Database
NQF	National Qualifications Framework

OBE	Outcome-based Education
OBET	Outcome – Based Education and Training
OECD	Organisation for Economic Co-operation and Development
P	P-value
PCA	Principal Component factor Analysis
PNI	Preference for Numerical Information
RC	Regression Coefficient
RMSEA	Root Mean Square Error of Approximation
RPL	Recognition of Prior Learning
RSA	Republic of South Africa
SA	Strongly Agree
SAQA	South African Qualifications Authority
SATS	Survey of Attitudes Towards Statistics
SDQIII	Self-Descriptive Questionnaire III
SelfEffAbsMeanOrd	Self-Efficacy Absolute Mean Ordinal
SELS	Self-Efficacy to Learn Statistics
SITSTATS	Situations that are commonly associated with statistical anxiety
SPSS	Statistical Package for Social Sciences
STARS	Statistics Anxiety Rating Scale
STASTATS	Statements related to statistics
UCT	University of Cape Town
UN	United Nations
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific and Cultural Organisations
UNICEF	United Nations Children's Fund
UNISA	University of South Africa
UWC	University of the Western Cape
WCEFA	World Conference on Education for All
WLSMV	Robust Weighted Least Squares

DEDICATION

I would like to express my heartfelt gratitude to everyone who played a role, and assisted me in the course of this dissertation, not forgetting those who constantly prayed for me. I dedicate this work you all.

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CHAPTER ONE

SCOPE OF THE RESEARCH

1.1. Introduction

According to Mda and Mothata (2000), the education system of a country reflects what the country values and holds dear. Since the 1994 general elections, the South African government has focused on the development of new educational policies. These policies have not only transformed the education system, which was highly fragmented and chaotic during the apartheid era, but also provided direction and support to students and academic institutions (Barth, Godemann, Rieckmann & Stoltenberg, 2007; Reddy, Juan & Meyiwa, 2013). This current research, therefore, focusses on lifelong learning (postgraduate programmes), from formal, through non-formal to informal education (Laal & Salamati, 2012).

Batanero and Díaz (2012) acknowledge that statistics is a section of the mathematics programmes for secondary and primary school in various nations. Various scholars highlight the utility of likelihood and statistics for regular life, its active role in other subjects, the requirement for a simple theoretical awareness in numerous occupations, and the vital role of statistics in emergent critical reasoning (Ottaviani & Batanero, 1999; Gal, 2002; Franklin *et al.*, 2005). Students from secondary and primary school are likely to develop statistical reasoning by designing research studies; formulating research questions; collecting data, applying comments, investigations, then tests; define and associate data sets; use and appreciate diagrams and events; suggest and validate decisions, as well as estimates that are built on data (Garfield & Ben-Zvi, 2008; Batanero, Burrill & Reading, 2011).

However, statistical cognitive is diverse from mathematical perceptive. Although together, these ways are vital to daily life, supplementing each other support the mathematics curriculum in general for students (Batanero *et al.*, 2011; Batanero & Díaz, 2012). As mentioned earlier, the teaching of statistics often connects statistics with the general process of inquiry, and involves doing calculations, or showing mathematical formulas, with limited break to design tests and examine statistics (Batanero & Díaz, 2010). Consequently, students complete their academic education with slight thoughtful of the elementary values underlying statistics examination, which explains many of the problems they meet with the practice of statistics in everyday and expert lives, or in statistics courses at university level (Batanero & Díaz, 2010; Cohen, Manion & Morrison, 2013).

The relationship between statistics learning quality and statistics learning productivity is crucial to the development of a high-quality educational system (Van der Wende, 2007). Within this relationship, initial learning statistics serve as the substance to re-define the self-development of statistics learners, facing the present challenges of a globalised society (Engeström, 2014). Pajares (1996) acknowledges that the self-efficacy of students has been the focus of research for decades, yet "there is no agreement on what factors enhance learner quality". Since quality learning of statistics is the critical factor, there is an urgent need to re-conceptualise how to prepare a generation of students, equipped to meet the demands of the 21st-century student (Tishkovskaya & Lancaster, 2012).

1.2. Study Problem

Although various studies on statistics education have been conducted worldwide (Shaffer, Hall & Van der Bilt, 1999; Ben-Zvi & Garfield, 2004), many aspects of statistics learning in middle developing countries, such as South Africa, has not been clarified, or explored (Bray & Thomas 1995). This indicates that knowledge failure in statistics is a serious educational learning issue of students all over the world. The impact of the problem is more accentuated in developing countries, particularly in Africa (Sawyerr, 2004). The consequences of knowledge failures in learning statistics have a dramatic effect on social, economic and innovation (Argote, 2012). Statistics form an integral part of many academy programmes (Nasser, 2004). Because of the consequences that knowledge failure in learning statistics could have on the sustainable development of a country, actions are constantly taken at universities, nationally and internationally, to overcome the problem (Delors, 1998).

Recommendations have been made at many international meetings regarding the reduction of knowledge failure in education to address the transformation of the HES (United Nations Educational, Scientific and Cultural Organisations [UNESCO], 2014; World Bank, 2011; Republic of South Africa [RSA], National Department of Education [NDoE], 1997b). South Africa ratified all the international decisions related to knowledge failure in HES (Allais, 2007). National policy and programmes also incorporated the issue of knowledge failure in statistics education, in higher education (Subotzky, 1999). All these strategies in learning statistics have been implemented in the South Africa, but the level of knowledge failure in statistics education is still rated among the highest in the world (Onwuegbuzie & Wilson 2003; Pan & Tan, 2004). Unfortunately, there is a significant lack of data, while the existent data are of poor quality (Judge, Puckett & Cabuk, 2004; Cherkassky & Mulier, 2007; Janssen, Charalabidis & Zuiderwijk, 2012). In 2004, South Africa consolidated 36 universities into 21 institutions that could promote social cohesion among all South African students (Cloete, 2006). However, policy and programmes are still developed at national level and implemented at university level (Caldwell & Mays, 2012). This situation is partly motivated by the lack of experts at the university level and the real lack of data and study at that level (Tremblay, Lalancette & Roseveare, 2012). Very few numbers of scientific studies have been undertaken on the subject in Africa (Mji & Makgato, 2006).

Among the following authors cited in this paragraph, one category focuses on undergraduate students and another category concentrates on post-graduate studies. The former category is separated into two categories; the principal category assesses the statistical reasoning of students (Garfield & Ahlgren, 1988; Gal & Ginsburg, 1994; Mvududu, 2003), while the second group does course evaluation (Latief, 2005; Makapela, 2009) in South Africa. The latter category concentrates on post-graduate studies (Gardner & Hudson, 1999; Perepiczka, Chandler & Becerra, 2011), with an exception that Gardner and Hudson (1999) mix undergraduate and post-graduate students in their studies. However, the small sample size and the diverse background of their students/participants make it difficult to generalise accurately to a wider population. Even though Perepiczka *et al.* (2011) focus on post-graduate students in USA, they do not consider the marital status, ethnic groups, postgraduate programmes, student status, and type of study, which could explain some influences in the learning status of the students. In addition, most of these research projects are only implemented in developed countries, such as Australia and USA. Little empirical research exists for similar initiatives in developing countries (Fuller, 1986). These facts, therefore, highlight the need for a university approach to the problem of knowledge failure in statistics education.

This situation raised many interrogations, which motivated the initiation of this current research. The principal research question is, therefore, “How can statistics learning oriented policies in South Africa be improved efficiently?” Many subsidiary questions are also raised; “What are the explanatory factors for the postgraduate students’ low level of statistics ability at UCT, UWC and the combined data of both universities?" "What are the attempts made, or actions already implemented, to reduce statistics learning failure?" and "What are the current and future consequences of statistics learning failure, if more attention is not paid to the problem?" The intention of this current research is to examine the knowledge level of postgraduate students, in applying appropriate statistical procedure in their studies.

Due to the progress made in statistical techniques over the years, involving new statistics tasks, as well as the differences in students' academic backgrounds, the Self-efficacy to Learn Statistics (SELS) beliefs of students might also be different (Zieffler *et al.*, 2008; Artino, 2012). The lack of statistical knowledge and practical experiences leads to anxiety among postgraduate students (in terms of attitude toward statistics, individual characteristics, social support, etc.) in their academic research (Perepiczka *et al.*, 2011; Zhang *et al.*, 2012). Students still encounter difficulties in identifying the extent to which statistical procedure is appropriate to answer research questions, or to evaluate a variety of misconceptions, when applying real world problems (Garfield, 1995; National Research Council [NRC], 2004). There is a lack of an effective approach for students to follow, in order for them to gain a better understanding and interpretation (self-regulation) of statistical procedures (Clark, 2012). Therefore, the poor performance of post-graduate students is differentially distributed among ethnic groups, and according to student status (Froehlich, 2015). Urgent action is needed to address this specific problem for solutions, as the number of students with inadequate knowledge in statistics could decrease dramatically, if more effort is applied to reducing the grave differences between universities (Gurian, 2010).

This phenomenon is not only the concern of statisticians, as many researchers are trying to find the suitable methodology, with the smallest possible bias, for estimating statistics learning (Ioannidis, 2008). Finding a lasting solution to this problem requires more knowledge about learning statistics, as well as the provision of reliable indicators that reflect the reality of different geographical areas (Ioannidis, 2008). Many methods have been applied, such as the multiple regression and structural modelling equation, to build models; however, they still have critical limitations and need to be improved (Mac Nally, 2000; Hox & Bechger, 2007). As with most social issues, the reliability of methods varies from one university to another, depending on the specific socio-cultural and economic environment (Fougeyrollas *et al.*, 1998; Nunnally & Durham, 1975).

In South Africa, as in many African countries, the problem of statistics learning is a major challenge for postgraduate students because of its complexity, lack of data and poor quality of existing data (Cherkassky & Mulier, 2007; Janssen *et al.*, 2012). Another concern for researchers and policy makers is the explanation of learning statistics failure, which involves a statistical model that is difficult to implement because of the weaknesses of existent data (Majone, 1989). In addition to these difficulties, an important insufficiency of scientific work, related to this issue in South Africa, has been identified (Banks & Banks, 2004). However, estimating the level of SELS beliefs at the university, and the combined data of both UCT and UWC, is an important scientific issue; therefore, finding research factors to explain the problem is a real challenge (Pajares, 1997). The development of a practical approach for post-graduate students to have a better understanding of applying statistical procedures effectively, adds to the significance of this current study.

To contribute to the body of knowledge on statistics learning issues, the researcher, in this current study, has set as the main objective, the provision of statistical information on the causes of statistics learning failure at the university level, for a better orientation of related programmes. The aims are, specifically, to:

- Determine explanatory factors of SELS beliefs;
- Assess the estimates of SELS beliefs levels at UCT, UWC and both scales;
- Compare the levels of SELS beliefs across universities;
- Predict the levels and trends of SELS beliefs across universities and for combined data of both universities; and
- Investigate a set of empirical results from multiple situations, as well as develop possible theories that explain and predict how to choose a relevant statistical test.

1.3. The status of students' knowledge of using statistical procedures

1.3.1. Context of Developed Countries

A broader responsibility, beyond national interests for developed countries, exists in the interdependent world to address universal issues of higher education. The system of higher education in the USA includes community colleges, four-year colleges and research universities. There are state, religious affiliated and private universities. One can hardly call it a system. Thullen Heyl and Brownell (2002) mention that no central body at national level controls, or coordinates higher education in the USA, even with respect to international programmes and activities. Concerning research and graduate education, the United States is reputed to have one of the greatest systems of advanced education in the world (Kezar, Chambers & Burkhardt, 2015; Alexander, 2000).

However, the weakening of public asset in education and academic research tends to reduce the ability of America's academic research to yield new acquaintance for revolution (Mohrman, Ma & Baker, 2008); although, the specific heterogeneous character of the American HES keeps them dominant in the world (De Wit, 2009; Clark, 1986). Many countries set the striving objective of providing their people with prevalent, permanent learning. This creates factual learning environment. However, the constant expansion of education and social capital are driving economic prosperity, national security, and social welfare (Duderstadt, 2009). In addition, HES in the world currently tends to solve significant problems linked to the general dynamic conditions of students, in which their particular interest is based on solutions; therefore, institutions are compelled to produce the real changes in social interactions (Fullan, 2007).

1.3.2. Context of Developing Countries

During the course of the last decades, much of Sub-Saharan Africa has suffered from deep poverty, corruption, disease, natural disasters and international conflict (Ake, 1991; Ikejiaku, 2009). More remains to be done; the capacity to use statistical data is still limited; the challenges are to fit in indicators into policymaking, in order to endorse exposed right to use data, to improve their use, and to increase statistics systems (World Bank, 2011; De Francesco, 2016). Data are useful and relevant for refining people's life everywhere. Higher education in Africa is vitally important to its development. African universities have the ability to transform themselves and promote national development (Altbach, 2009). Unfortunately, its universities suffered from an enormous decline in government resources for education. Evaluating contemporary education systems in Africa is difficult, since it is a challenge to generalise (Sawyerr, 2004).

Regarding sub-Saharan countries, there is a great variety in the traditional cultural institutions and practices of ethnic groups. In many cultures, authority is centralised, leadership tends to be inherited, and advancement is limited to particular lineages and clans (Omolewa & Kellaghan, 2003). Position of prestige, authority and leadership are achieved based on the individual's ability, knowledge and skills. However, the meritocratic assumptions in Western systems of education and evaluation would differ from the African traditions. African societies are different because some regions were under Western cultural influences. Such cultural contact was marked by the willingness and openness of traditional cultures to change, and their acceptance of a new ideology (Omolewa & Kellaghan, 2003).

An attempt to address these limitations of knowledge and space (variation in educational activity on the continent and the complexity of that variation) is inadequately presented. Learning had standard criteria, by which those, who engaged in learning, were certified as having been successful (Omolewa & Kellaghan, 2003). This creates an avenue to improve the quality of trans-border higher education, in the logic of ensuring its occasions, enhanced by innovative actions in higher education. The potential is summed up in these two aspects, adding the internationalisation of higher education, as a root for the expansion and exhibition of scientific knowledge at various levels. Since international donors (partners such as World Bank [2008] and United Nations Educational, Scientific and Cultural Organisations [UNESCO] 2009]) supported statistical capacity and the application of statistical procedures, as well as development in developing countries in 2008, much progress has been made concerning these issues. Recently, the 2009 Dakar Declaration on the development of statistics, reiterated that intensive effort is required to use statistical data more effectively, to support programmes, as well as strengthen and sustain the capacity of statistical systems, especially in developing countries (UNESCO, 2009).

Empirical studies, conducted at various universities, are genuine evidence that confirm the interactions between changes in academic context, the students' influence on teaching, as well as their learning outcomes (Laurillard, 2013; Biggs, 2011). An attempt to restructure learning cultures to respond to frameworks, may unfortunately discourage innovation and enhance passive, as well as instrumental attitudes to learning. Regarding statistical learning, considerable literature is available on self-efficacy to learn statistics among students in developed countries; however, comparatively little scholarly attention was given to Africa (Biggs, 2011; Knight & Yorke, 2004).

Concerning the application of statistical procedures, universities are expected to increase graduates' total understanding of statistics, as well as assist them with special and broad skills, regarding their capacity to innovate the ability to learn (Schunk, 2008). The real impact of the learning programme focusses on the interactions between certain key changes, such as academic aspects, teaching and the curricula, students' abilities and their feedback (Biggs, 2011). Education is likely to be transformed as a pedagogical exchange, in which the lecturer is considered the producer of knowledge and the student, the consumer of knowledge (Molesworth, Nixon & Scullion, 2009). Ultimately, rather than merely stipulating new procedures to enhance higher education, mechanisms may be perceived as a way to transform academic values and relationships, to comply with market frameworks (Naidoo, Shankar & Veer, 2011).

1.3.3. Context of South Africa

Given that little is known about statistics problems among university students in South Africa, the present study was conducted, in order to evaluate whether the postgraduate students had any differences about self-efficacy in learning statistics at Western Cape universities. The apartheid system promulgated that some ethnic groups had limited ability, and, therefore, were only allowed to study in specific programmes and courses (Swartz & Foley, 1996; Higher Education Quality Committee [HEQC], 2006). For a variety of reasons, black students entered university into fields such as social work, or divinity (Badat, 2016).

Therefore, South African advanced education reform was challenged with collective, administrative and financial problems, arising from global environments, after the democratic elections of 1994 (Scott, Yeld & Hendry, 2007). Higher education in South Africa involves the interaction of policies to engage problems of reparation, and admission to higher education remains one mechanism for the achievement thereof in South Africa (Horsthemke, 2004). An introduction of a quality assurance framework enables admission, by improving student success, as opposed to simply ensuring their participation (Akoojee & Nkomo, 2007). A comprehensive quality assurance agenda, with fixed pledge to admission, would probably reply suitably to national development prerogatives of higher education access (Akoojee & Nkomo, 2007). South African universities have engaged various initiatives to substitute, as well as respond to the changes in society, while preparing students for the realities of increasing globalization.

The proper expansion of expertise could help to achieve academic performance, enabling students to encounter the requirements of industry. University staff members are progressively redirecting students to address the social imbalances inherited from apartheid, as well as respond to social needs (Nicol & Macfarlane-Dick, 2006).

Real world difficulties are multifaceted; therefore, it is vital to mix knowledge and information from various academic disciplines, including education, engineering, art & humanity, applied, natural and social sciences (Griffiths*, 2004). Based on what is learnt from diverse experiences, the aforementioned challenges are addressed simultaneously, in order to fulfil the reality of learning statistics (Fink, 2013). Shared learning, through teamwork, includes the organisation of academic programmes, as well as the pathway for careers (Brundiers, Wiek & Redman, 2010). This current study, however, promotes a better understanding of the interaction between graduate students and their environment, and collaborates on common environmental issues. Understanding how the notion of statistics has been combined into academic research, is indispensable to contextualising practices and behaviours for quality assurance (Brundiers, Wiek & Redman, 2010). This current study opts for a large contextual background to assess the postgraduate students' ability to apply statistics skills and deal with social and behavioural sciences at the relevant universities. An important aspect to consider is that these students have learned statistics courses, in some cases, for one or two semesters, in other cases, for three years, as part of their programme. As mentioned previously, the statistics course is a tool for the understanding of research projects. It also contributes to the accomplishment of a specific research situation, instead of being considered a pure academic discipline (National Research Council [NRC], 2012). However, the research methodology and statistics courses are intended to expand students' computational skills, with or without the conceptual understanding of theory, or the use of computer packages (Chance, Ben-Zvi, Garfield & Medina, 2007).

South African scholars face serious challenges to sustain research and intellectual activities around socio-cultural diversity, which is still under pressure. The legacies of Apartheid remain a barrier, when developing a critical theory of diversity for the recognition of difference that advances the cause of social equality, through students who retard it, or undermine it (Jansen, 2004; Higham, 2012). The South African government faces very hard queries about how best to reform the HES. The significant skills allow students to think more critically and learn independently, thereby reducing dropout rates, achieving full potential, and utilising better knowledge in industry. In addition, good statistics are essential for developing policies that effectively improve the welfare and productivity of students (Altbach, Reisberg & Rumbley, 2010).

1.4. The Higher Education System Reconstruction in South Africa

The South African Qualifications Authority [SAQA] Act (Republic of South Africa, Act 58 of 1995) offers the background, which accommodates South African education and training, in the democratic era. South Africa has inhabitants closely 50 million, of which more than 41 per cent stayed in the worse countryside areas, and near to 54 per cent aged less or equal to 24 years (Blom, Parker & Keevy, 2007). South Africa is experiencing fast urban relocation, particularly males aged between 20 and 34 years. As a result, a high proportion of households in rural areas are headed by young women (Blom *et al.*, 2007). The inheritance of Apartheid remains an important task in South Africa, with various formal and informal initiatives underway to advance the level of education of black people (Fiske & Ladd, 2004; Leibbrandt, Woolard, McEwen & Koep, 2010). Although the levels of discrimination persist great (Gini coefficient = 0.35), they are no longer exclusively founded on ethnic separations (Blom *et al.*, 2007). The joblessness occurs mainly in the less than 30 age group (49 per cent in 2002). Unemployment is advanced among females compared to males. Most black employees remain in elementary occupations (Blom *et al.*, 2007).

All countrywide known diplomas are chronicled in the National Learners' Records Database (NLRD), which include both unit standards-based qualifications, and non-unit standards-based qualifications (South African Qualifications Authority [SAQA], 2013). After a lengthy review process, the new National Qualifications Framework [NQF] Act (Republic of South Africa [RSA], Act No. 67 of 2008) was passed in 2008, with effect from 1 June 2009. A single Ministry of Education was divided into two: a Ministry of Higher Education and Training (MHET), and a Ministry of Basic Education (MBE). This meant that the MHET would be accountable for universities, universities of technology, training colleges (for example, nursing, agricultural, etc.), colleges of further learning and practice, mature elementary instruction and the entire working out sector.

Diplomas and unit values are described as education results and evaluation standards. One recognition is equal to ten theoretical hours of knowledge. If non-formal and relaxed learning leads to recorded criterions in the NQF, and the providers are accredited, the learning can be formally recognised (RSA, SAQA Act No. 58 of 1995). RPL rule permits applicants to attain credentials, in share, or in filled, done the recognition of prior learning. SAQA arrived into a research corporation with the University of the Western Cape, to research why recognition of prior learning (RPL) has failed to take off as envisaged. The research is being conducted at a variety of different sites. Extensive regulation is approved, determined mainly through the developmental program, again leading in this country (SAQA, 2013; Singh & Duvekot, 2013).

Higher education shows an important role in the community, traditional, and financial growth of the country (National Commission on Higher Education [NCHE], 1996). South Africa's change from Apartheid to Democracy needs that all current rehearses in education, institutions and values to be revised in terms of their appropriateness for the new era (Harvey & Knight, 1996; Henrard, 2002). The development of learning stimulates intellectual dynamisms of all the people, towards achieving the challenge of renovation and expansion of higher education in South Africa (Republic of South Africa [RSA], National Department of Education [NDoE], 1997b). However, the challenges in South Africa are to re-dress past disparities, alter the HES, help a novel communal instruction to light countrywide requirements, as well as opportunities, and respond to new realities (RSA, NDoE, 1997b). Studies on statistics learning in South Africa, conducted over several decades, reveal that progress has been made in research methods leading to greater observed effectiveness in learning. This progress also emphasizes the reform in the learning process (Sammons, Hillman & Mortimore, 1995; Nomlomo, 2007).

The Education White Paper 3 entitled, "A programme for the transformation of higher education", emphasizes the framework for change that enables the eradication of fragmentation, inequality, inefficiency, and creates an education environment, which releases the original and intelligent dynamisms of students, to achieving the objectives of change of HES (RSA, NDoE, 1997b). The reconstruction of the advanced learning system contributes to satisfying the learning needs of students, through the development of abilities (Boud, 2000; Biggs, 2011). Singh (2001) and Singh (2011) argue that the clarity of social justice issues in higher education responsiveness is most likely difficult to achieve. This change prepares students to brand the greatest usage of their aptitudes, and the options accessible at the university, for self-fulfilment. Cook-Gumperz (1986) emphasises that bringing about social change and stability, provides a set of guidelines about the use of knowledge. In case the outcomes are not as expected, the problems are seen as attributable to educational failure.

This transformation attempts to achieve equity in the distribution of options among students. It addresses the development needs of learning in a knowledge-driven and knowledge-dependent society (Singh, 2001; Badat, 2010). In addition, it provides the ever-changing labour market with high levels of abilities and skill, which are essential for the progress and wealth of a student (Brennan & Naidoo, 2008). Therefore, Fiske and Ladd (2004) argue that the evaluation of transformation strategies have to apply equally to educational opportunity and competence.

Regarding the socialisation aspect, the reconstruction of higher education enables students to become responsible and to perform critical constructs (students express their knowledge, using critical thinking, which allows diverse values to surface, be questioned and more deeply understood). Transformation inspires the expansion of a deep size and a readiness to review, and restart, main ideas, strategies and practices, based on the shared moral (Pityana, 2003; Maharajh, Motala & Scerri, 2011). In its present state, the HES is unable to meet the moral, political, social and economic demands of the new South Africa (Maharajh *et al.*, 2011). However, despite the deficiencies of the apartheid legacy, an academic expertise of higher education remains harmful to the countrywide attention. (Tate, 1997; Ross, 2009; Arnold, 2014). Nevertheless, the reconstruction of higher education has to address the discriminations, inequities and misrepresentations that resulting from the apartheid legacy. Higher education has to be renovated to see the contests of a new democratic culture, dedicated to equity and justice, in order develop a better environment for students (Viljoen, 2005).

1.5. Research Questions

The primary research question of this study is:

- Which approach can be used effectively to provide post-graduate students with a better understanding and interpretation (self-regulation) of statistical procedures in academic institutions?

However, this main research question is sub-divided into additional specific questions:

1. (a) What is the graduate student's experience level in statistics, research methodology?

   (b) What is the graduate student's statistics anxiety level?

   (c) What is the graduate student's attitude toward statistics?

   (d) What is the graduate student's level of perceived social support, and

   (e) What is the graduate student self-efficacy level?
2. What are the effects of the individual's characteristics, emotion, behaviour and social support on the SELS beliefs per university?
3. What are the similarities and differences of the dependent variables across universities, and their impact on the SELS beliefs at both universities?
4. What are the factors that predict SELS beliefs, significantly, per academic institution?
5. How do the students choose the appropriate statistical test?

1.6. Justification/Rationale

The researcher's intention of conducting this current study is to contribute towards the learning ability development of postgraduate students, in the application of skills in statistics that would enhance their performance in the academic environment, particularly in the field of medical, social and behavioural science research. Considering that statistical effectiveness requires a skilled student, the aim of the researcher is to design a statistical model, to assist in assessing the learning level of students. The proposed model of this current study is a replicable statistical evaluation learning process that could be applied to measure the effectiveness of statistical skills, as well as answer questions related to real world problems. This framework could be used as a model for academic research in a higher educational environment that could continuously progress the excellence of learning statistics. The potential contribution of this current study is that this proposed model could evaluate the incoming students' profile and easily identify their level of understanding and interpretation of statistics. Therefore, it would equip universities with practical measures that could be used to assess learning problems. Based on the aforementioned rationale, a set of solutions will be generated through this research study's findings.

Students' attitudes affect their learning process (Mvududu, 2003; Perepiczka *et al.*, 2011). If the attitude or perception of a student is negative, the learning process can be delayed. If the attitude of students is positive, on the other hand, the learning process can be enhanced. Barrell (1998) identifies that, in developing countries, high school graduates entering university do not appear to be sufficiently prepared in statistics. The influence of the type of study environment affects the performance of students at post-graduate level (Ali, Haider, Munir, Khan & Ahmed, 2013; Alos, Caranto & David, 2015). In a South African context, various authors (Altbach & Knight, 2007; Heath, Rothon & Kilpi, 2008; Altbach Reisberg & Rumbley, 2009; Kuh, 2009) emphasize that students from foreign countries tend to perform better in their statistical programme in higher education, as compared to the local students. In addition, Perna, (2005) explores the economic benefit of Higher Education that graduate students realize, in terms of differences in ethnic groups, gender and even in post-graduate programme achievement rates. Therefore, the researcher investigates the indicators leading to these gaps, focusing on postgraduate students of medical, social and behavioural sciences, according to their context.

Universities in South Africa are committed to providing the best quality of supervision to their students, through an adequately qualified and committed team. The researcher's attempt in this current study is of a similar nature. The researcher anticipates that, if the model, which this current study proposes, is adopted by South African universities, they will be able to produce skilled graduate students, and establish an effective learning environment. In addition, this current research aims to identify factors associated with learning statistics that might inform researchers, police-makers and other stakeholders to develop relevant preventions and interventions for research.

1.7. Limitations

The first limitation to consider is that this current study is only restricted to the students in the medical, social and behavioural sciences departments of their respective academic institutions. Therefore, to generalise the outcomes to all students at all universities in South Africa requires careful application. Secondly, it is important to consider that no method is faultless and will be successful with all students. Many studies in statistics education reveal that misconceptions are often compelling and resilient among students (Garfield, 1995; Garfield & Ben-Zvi, 2007; Huck, 2009). Students are reluctant to transformation, even when challenged with indication that their perceptions are inaccurate, which is only part of the problem. Additional limitation is whether students are sufficiently committed to engage with learning new concepts.

1.8. Definition of Keywords

- **Statistical procedure** is a systematic way of doing a task, which implies a logical arrangement of steps (Burns & Burns, 2008). The appropriate statistical procedure is subjected to the study problem and the type of data collected (Kothari, 2004; Onwuegbuzie & Teddlie, 2003). Lehmann and Romano (2006) define statistical procedure as a way of providing a suitable summary of the data, or designating what evidence is accessible about the unidentified parameter or distribution. The relevant information is used as a guide in many matters; however, it cannot provide the only foundation for any specific choices, unless the emphasis is on the inference, rather than the decision aspect of the problems (National Research Council [NRC], 2002). Additionally, Akaike (1970) describes statistical procedure as the ideinvestigation of the predictor, when the stochastic process under comment is an autoregressive process made from inactive and independent inventions.

- **Academic environment** is a setting where instruction is provided to students (Zimmerman, 1989). It also defines as an atmosphere that greatest makes students for their upcoming expert life and contributes toward their individual expansion and social well-being (McLean & Gibbs, 2010). Various issues meaningfully affects the manner students observe and understanding their edification (Bandura, 1993).

- **Postgraduate research** represents a prescribed area of study that is recognized by a university, or institute of higher learning (Clark, 1995). It involves investigating and writing critical, accurate, valid, timely research, based on scientific inquiry (National Research Council [NRC], 2006). The scientific method is based on the statement that everything in the universe is linked by cause and effect (Ary, Jacobs, Irvine & Walker, 2013).

- **Social support** denotes to the several sources of support (for example, assistance/help that people receive from others) and generally classified into two (sometimes three) main categories: emotional, active [and sometimes informational] support (Jang, 2012). An example of supportive resources can be emotional [nurturance], tangible [financial assistance], intangible [personal advice], informational [advice], or companionship [sense of belonging] (Jang, 2012; Williams, 2014). Support can come from many sources, namely: family, friends, student peers, neighbours, co-workers, organizations, or government (Williams, 2014).

- **Self-efficacy** is described as a personal belief that an individual will be able to succeed in a particular situation, or accomplish a specific task (Bandura, 1994). Self-efficacy theory understands the relationship, based on the social cognitive and structure similarities (Pajares, 1996). According to Bandura (1997), it is the personal opinions held by individuals that they own the ability to achieve certain tasks in certain fields of functioning, under certain circumstances. Self-efficacy to learn statistics is a tool, intended by Finney and Schraw (2003), to measure a student's personal beliefs in their ability to learn to complete specific statistics tasks in the future.

1.9. Thesis Outline

In the light of the questions raised in the Study Problem section, the following content has been assigned to this thesis, which is divided into nine chapters, namely:

1. Scope of the research.
2. Conceptual Framework of self-regulation learning approach.
3. Literature Review.
4. Research Setting and Methodology.
5. Findings: A case of UCT.
6. Findings: A case of UWC.
7. Comparative quantitative results of both universities.
8. Discussion of the findings.
9. Conclusions, recommendations, contributions and limitations of the study.

Chapter 1 comprises the researcher's introduction of statistics learning failure, as well as the research problem. The scientific, social and economic importance of this topic, from international, national and institutional perspectives, is highlighted. The necessity for such study, research questions and objectives are presented. The geographical, political, socio-cultural and economic context, in which the study is conducted, is also considered in this chapter, as well as the rationale for undertaking this research study. Some keywords are defined.

Chapter 2 is committed to the conceptual framework of the self-regulation learning approach. Multi-dimensional concepts and definition of learning, which vary with different schools of thought, are explored. The enactment of these methods attempts to describe learning statistics, as well as how, successfully, it should be the objectives of UNESCO, the World Education Forum and the White Paper 3 policies on Higher Education in South Africa. In this chapter, the researcher explains the conceptual framework, and elaborates on the analysis scheme of self-efficacy beliefs with other variables. The evaluation of external feedback from a supervisor, peer and computers enhance performance of students in statistics. Finally, the rationale of the self-regulation is discussed. The theory seems better appropriate to learning statistics. However, the graduate students manage their academic works with minimal supervision and depend on their aptitudes and initiatives to achieve their academic research duties.

In **Chapter 3** the researcher appreciates the sights existent methods of learning estimates found in the literature, as well as evokes some existent models, including their advantages and disadvantages. Also, the issue is restored to its scientific context by reviewing existent literature on socio-demographic, emotion, behaviour and environmental factors of SELS beliefs. In this chapter, an overview of existent scientific researches on the estimate and prediction methods on this matter is conducted. In general, the chapter entails a summary of the knowledge on the causes, issues, challenges, estimates and the identification of some aspects that have been of little interest in previous researches, but which require close attention. The researcher focuses on a review of the strengths and weaknesses of policies formulated, as well as previous actions undertaken, to reduce statistics learning failure.

Chapter 4 is focused on the research design and methodology. A brief description of the University of the Western Cape (UWC) and the University of Cape Town (UCT) was emphasised on their academic research profile. Academic research promotes the knowledge, abilities and skills which allows graduates to contribute to development towards better fairness and social progress. Authorisation to lead this research study was received from both universities. The pilot survey and its results enable the researcher to make the corresponding adjustments to the questionnaire items. Data chosen for this study is reviewed and the statistical methods of analysis used are presented. The reliability and the validity of the instruments were vital for the trivial. A high value for Cronbach's Alpha confirms good internal uniformity of the items in the scale and the analysis of the data should use the subscale instead of individual items. This chapter includes the definition of the main concepts and indicators, the reasons behind the choice of the datasets and the methodology, the quality of the datasets and the methodological limits of the research, as well as their impact on the findings.

In **Chapter 5**, the characteristics of postgraduate students were examined at UCT. The impact of independent variables on SELS beliefs revealed that the *"experiences"*, STARS and *"effort"* components were significantly different in means scores of SELS beliefs. In addition, the main choices taken in the model structure for "ordinal regression" were, defining which explanatory variables to include in the model, as well as choosing the link meaning that established the model suitability. Furthermore, the ordinal regression model, using the logit link function, was the best model, with a high prediction accuracy of 73% for all three categories combined. Their mechanisms of actions as well as contributions are highlighted. Moreover, the qualitative findings, originated on the comments of the participants, highlighted a deep understanding of the perceived failures in selecting suitable statistical tests.

In **Chapter 6**, the findings of the univariate analysis focus on the characteristics of postgraduate students at UWC. The impact of independent variables on the SELS beliefs indicates significant differences between their mean scores during the t-test or ANOVA test of their groups. These variables are marital status, postgraduate programme, SITSTATS, STASTATS, overall STARS and research methodology. The dispersal of values for the outcome variable enables the best choice of the link function to provide a good fit for the data. The complete model using the Cauchit link appeared to be the best model at UWC, based on the model fitting statistics, the correctness of arrangement results, with the great expectation accuracy (75.49%) for all three groups. Additionally, the transcribed responses from the participants on the choice of an appropriate test are reported as the findings, grouped into themes and sub-themes.

In **Chapter 7**, the researcher presents the description of the variables for the combined data from UCT and UWC. Across universities, some comparisons are made and the results indicate that *gender, age groups, ethnic groups, "effort", social support* and *STARS* components are significantly associated to the academic institution. Furthermore, multivariate analyses estimates of SELS beliefs, using the combined data approve that an ordinal regression model, using a complementary log-log link function was the best model. This model shows a high prediction accuracy of 60% for all three categories combined. These findings provide an overall of the student's level of learning statistics, but also the degree of contribution to sustainable development of learning statistics, at the Western Cape universities. This model has the advantage of fair comparability between universities, treated on the same basis of a regression model. For the qualitative analysis, to avoid repetition, the findings presented in Chapters 5 and 6, are discussed in Chapter 8.

In **Chapter 8,** the evaluation of the knowledge development and learning approaches in statistics are complete across UCT, UWC and the combined data. The inputs and outputs of the prediction of SELS beliefs at each university and combined data levels are highlighted. In this chapter, the results from the analyses and forecasts in Chapters 5, 6 and 7 are confronted with knowledge from literature reviews and the context of the study. Assessment comparison of each variable across universities is done. The appraisal of the qualitative findings at UCT and UWC indicate that both universities have shed significant new light on what was similar, or different, about the collective systems, as well as the details behind the similarities and differences. The limitations of the Ordinal Regression Model and Likert-type scales are discussed.

Chapter 9 comprises the conclusion, as well as recommendations to improve actions against statistics learning failure in Western Cape, South Africa. However, at UCT, the academic variables revealed positive regression coefficients, indicating that students, who scored higher levels of satisfaction for these explanatory variables, were likely to achieve a higher level of SELS beliefs. Similarly, further analysis revealed that the influence of belonging to a particular department, explained the importance of how experiences in research methodology and experiences in statistics acquired over years, enhanced the SELS beliefs levels of students. The perceived failure to choose the right test, as presented in Chapter 5, mirrored the lack of information, confusion in the application of real life problems, as well as too little evidence. At UWC, the students, who scored greater levels of approval in *ethnic groups* and *postgraduate programmes*, were probably to have greater satisfaction with the SELS beliefs. Unfortunately, the *experience in statistics* tended to reduce the confidence of graduate students. Regarding self-efficacy to choose a statistical test was associated with anxiety and depression. Students with a low SELS beliefs, were confused and frustrated about their performance. Consequently, the choice of the right statistics test was related to anxiety, depression and helplessness. Integrating the qualitative and quantitative results, the predictor factors of SELS beliefs, as well as the quality of the choices of statistical procedures factors, improved the credibility of the findings, while also signifying that the research design, adopted for the study, was both valid and reliable. This complementarity of the research findings ensure credibility to the research strategy implemented. However, it is imperative to stress the need for these criteria to be updated, or revised periodically, to ensure changes in the external and internal environments of higher education have influenced the way in which the learning statistics dimension has been established. The results of this current study contribute to existing knowledge, methodologically and theoretically, as well as in terms of the development of policies and practices. A regular execution of the survey would be very useful for the monitoring and implementation of programmes and projects.

CHAPTER TWO

A CONCEPTUAL FRAMEWORK OF SELF-REGULATION LEARNING APPROACH

2.1. Introduction

In this chapter, the researcher presents the conceptual framework of this current study. The manner in which postgraduate students could learn statistics, through their involvement in academic research, is examined. Students learn through interactions with supervisors, peers, parents and coaches in their environment. Parents use learning to reinforce values related to statistical procedures and work ethic. Coaches emphasize hard work and teamwork that could influence students' experiences. Peer interactions appear to be the most meaningful aspect of adult learning participation (Carter & Kennedy, 2006). Particular attention is paid to their predisposition towards the field and the course, as well as their social support, when explaining their ability to apply statistical procedure in their academic research.

Self-efficacy in learning statistics is used extensively in this chapter. One of the most important aspects of the chapter is the hypothesis that the production of self-efficacy in learning statistics is a function of individual characteristics of postgraduate students, their behaviour, environment and their adjusted needs from feedbacks. The researcher presents empirical evidence to support this hypothesis, as well as highlight the fact that the supervisors' feedback on the performance of students are well interpreted, constructed and internalised by the students, which should produce a direct improvement on subsequent learning (Nicol & Macfarlane-Dick, 2006). Bandura (2012) argues that self-generated feedback is observed when students refine an interpretation of the task and adjust internal goals, tactics, as well as strategies.

2.2. Approaches for improving the quality of learning statistics

Learning is a continued phenomenon, with multi-dimensional concepts and definitions, which vary with different schools of thought (Cohen, Manion & Morrison, 2013). Research studies conducted over several decades have revealed that some progress has been made in statistics learning and research methods. This progress has been observed as most effective for studying and describing the reform in the learning process at UWC (Sammons *et al.*, 1995;

Nomlomo, 2007). Jean Piaget, who conducted a systematic study of children's cognitive development, asserts that a learner is fed by the elderly in its environment, which includes his/her teacher (Tennant, 2006; Chiappeta, 1976). Teachers tend to do everything, by feeding learners, which is contrary to students, who are assumed to have the capabilities to learn on their own, through various activities, such as reading books and learning from effective listening (Postman, 2009). Regarding the maturity of a student, who is assumed to have the capabilities to learn on his/her own, according to Babbie (2012), it is clear that some of the expectations have been unfair. For example, when producing research with the use of statistical tools, it can be verified whether the student is adequately mature in research by his/her choice and use of the appropriate statistical tools. It is also obvious that different skills in research emerge in individuals. Therefore, the use of statistical instruments depends not only on the individual's background, but also on other variables, like behavioural characteristics and environmental support. Undoubtedly, the institutional context plays a vital role in research, as the institutional context can improve the performance of the student (Conner & Rabovsky, 2011).

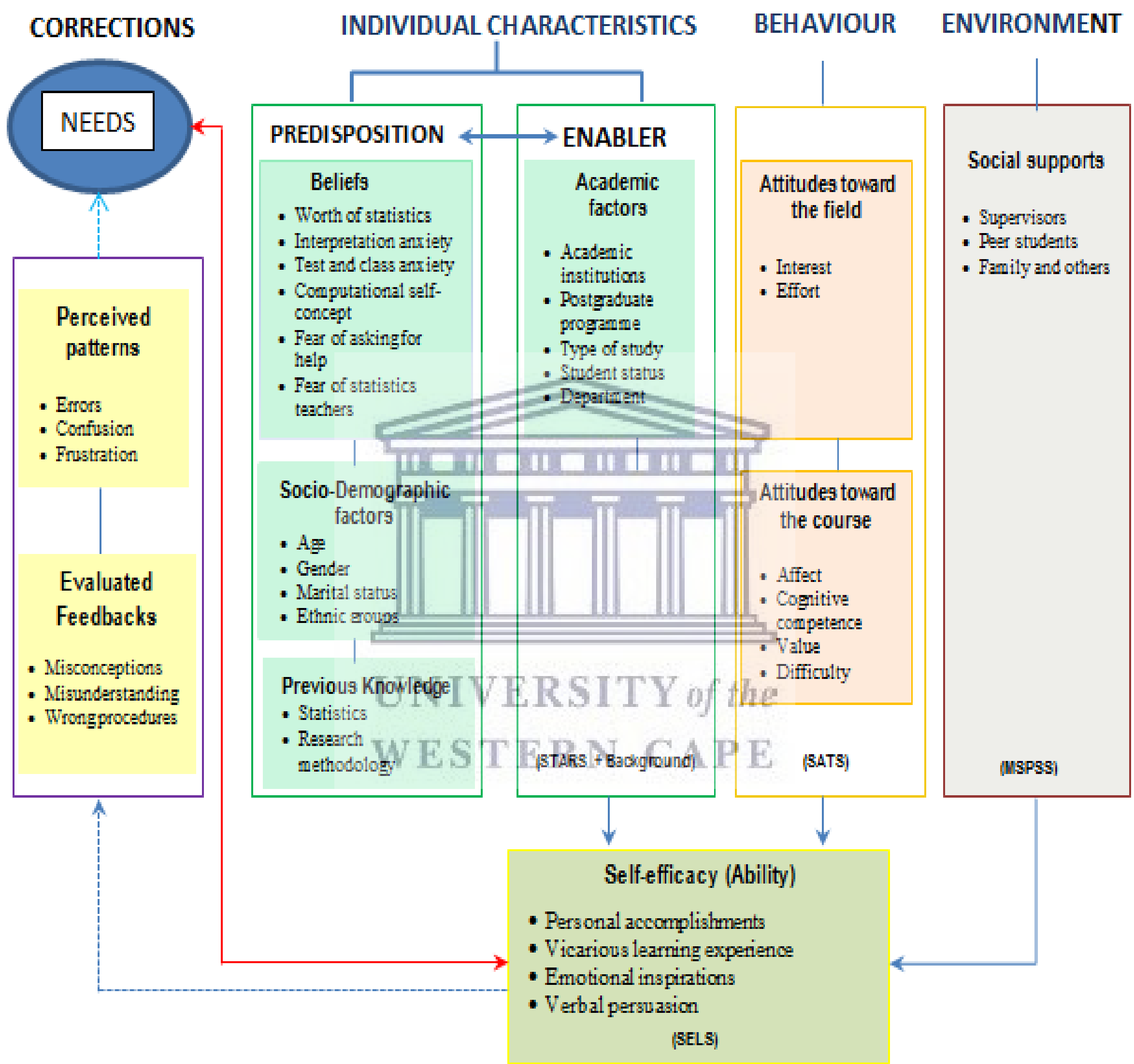
The main conceptual constructs that underpin this current study include the self-regulation learning approach and the interpretive approach. The focus of the implementation of these approaches attempts to define learning statistics, as well as how, effectively, it should be the objectives of UNESCO, the World Education Forum and the White Paper 3 on Higher Education in South Africa. However, a better understanding and interpretation of statistical procedures in academic research are effectively addressed (Creswell, 2014).

2.3 Self-Efficacy Theory to learn statistics

The conceptual framework diagram (Figure 2.1) below describes the relationship between the level of SELS beliefs (main factor) of respondents and independent variables. These independent variables include attitudes, beliefs, previous knowledge, social support, academic and socio-demographic factors influence the level of SELS. Additionally, the level of SELS beliefs reveals the needs (feedback patterns from supervisors, mentors) of students and the relevant adjustments.

The study of personal ability and the role of opinions in social reworking and adjustment, have a long history in clinical, behaviour and social thinking (Maddux, 1995; 2013; Bandura, 2001). The theories of achievement motivation (McClelland, Clark, Russell & Edgar, 1953;

McClelland, 1985), effectance motivation (White, 1959), social education (Rotter, 1966), and helplessness (Maier & Seligman, 1976), are a few of the concepts that have attempted to explore and elucidate the connection between awareness of individual capability and adjustment. In addition, Bandura (1977) introduces the construct of self-efficacy theory and produces more research in clinical, social and personality psychology (Bandura, 1982; 1986).



Legend:

Relationship between variables; Feedback patterns; Adjustment feedbacks

- SELS: Self-efficacy to learn statistics scale
- STARS: Statistics anxiety rating scale
- SATS: Survey attitudes toward statistics
- MSPSS: Multi-dimension scale of perceived social support

Figure 2.1: Conceptual Framework Diagram

Self-efficacy is the judgment an individual makes to execute a particular task, as well as the expectations about behavioural skills and capabilities (Bandura, 1978). Schwarzer (1992) asserts that self-efficacy differs in individual's feeling, reasonning, doing and performance.

Bandura (1997) determines four causes of information that students apply to measure their efficacy, including performance outcomes, indirect experiences, forms of social encouragement and expressive stimulation. These mechanisms allow students regulate if they trust they are enough competent to attain specific tasks. Schunk and Pajares (2009) explain that students with high levels of self-efficacy approach hard tasks as challenges to leading slightly than as fears to be escaped. Alternatively, it is a self-confident understanding of an individual's competence to proceed with certain tasks or situations. Individual's feelings affect the level of his self-efficacy.

2.3.1. Performance outcomes

Bandura (1997) argues that the way students interpret their actual performances should afford the most dependable information for assessing self-efficacy. A student, who have confidence in being bright to accomplish a task, can bearing a more vigorous and self-reflection in a sense of having aptitude to regulate environmental issues by taking adaptive achievement. Practices can affect the aptitude of a student to complete a given task. If an individual has done well in doing a certain task, before, s/he is more expected to be able about performing a related task, or similar task, just as well (Redmond, 2010). Student is more likely to try tougher and comprehensive the task with a much higher result. Similarly, (Redmond, 2010) acknowledges that prior successes increase mastery potentials, while recurrent failures lesser them. Bandura (1995) argues that self-efficacy refers to an individual's confidence in his/her capabilities to organise and execute the tasks of action required to resolve relevant problems. Alternatively, it is what an individual believes s/he can achieve, by employing whatever available skills. Self-efficacy beliefs influence the choices students make. Most students involve in tasks they feel able and confident to execute, and stay away those they do not (Schunk & Pajares, 2009). Competence determines how much effort students have to spend on a task, how long they will persist when challenging difficulties, and how strong they will prove to affront difficulties. In fact, the advanced the level of ability is, the better the strength, determination, and flexibility. Similarly, abilities also effect the extent of pressure, anxiety and behaviour that students' knowledge, as they involve in a task and the level of achievement they understand (Schunk & Pajares, 2009).

2.3.2. Vicarious experiences

This source is mentioned to as demonstrating, as it generates potentials in observers that they can progress their own performance, gain knowledge from activities they have observed other students perform successfully (Schunk & Zimmerman, 2007). A vicarious experience increases self-efficacy, which can cancel following performance failure. Students, who perceive similar peers be unsuccessful, may trust that they lack the ability to thrive, which could discourage them from attempting the task, or it could motivate them to accomplish the task. Students frequently seek role reproductions with potentials they appreciate, and abilities to which they seek. Role models could enable and connect principles that will encourage the ability and path of an individual's self-reflection (Schunk, 1995). Experience is, basically, what individuals choose to attend to, implying that the self-belief, which influences those choices, is contributory in defining incidents, and providing a way through which students are able to work out control over the events that affect their lives (Schunk & Pajares, 2009). They have a greater attention in actions such as, setting challenge goals, maintaining a strong commitment to them, and increasing their efforts when facing of disappointment. In addition, they recover their confidence effortlessly after failures. These failures can be attributed to inadequate effort, or poor knowledge and skills, which they believe they are able of gaining. High SELS beliefs helps create feelings of peacefulness in approaching difficult tasks and activities (Pajares & Schunk, 2001; Bandura, 2006). On the contrary, students with low SELS beliefs may trust that tasks are tougher than they actually are; a confidence that raises nervousness, unhappiness, provides a slight visualisation of how best to explain a problem. Because of these influences, SELS beliefs are resilient causes and prognosticators of the level of achievement that students reach. Based on these explanations, Bandura (1986; 1997) has completed the strong statement that personal SELS beliefs establish the main issue of social action. According to SELS beliefs theory, students are more probable to be occupied in tasks that or which they have high level of potentials and less possible to involve in those they feel uncomfortable (Schmidt & DeShon, 2010).

2.3.3. Social/Verbal persuasion

Individuals are able to make and change self-efficacy beliefs because of social encouragements they obtain from others (Bandura, 1997). Persuaders show a significant role in the growth of an individual's self-efficacy. This component refers to activities that urge individuals, over proposal, into trusting that they can finally handle precise tasks successfully; for example, "I know you can do it". To be more effective, persuaders have to cultivate a student's views in their abilities, while confirming that the success is possible. In addition, coaching and giving evaluative comment on performance, are some examples of verbal encouragement (Bandura & Cervone, 1986). Although Schunk (1995) acknowledges that positive response can increase students' self-efficacy, the increase will not bear, if they, then, achieve poorly. Just as positive encouragements might inspire and allow, negative influences could reduce and weaken self-efficacy. In social cognitive theory, an individual's functioning, results from a relationship among personal factors, in the form of cognitions; affect and biological events; as well as behavioural and environmental influences, in which, individuals are proactively involved in their particular development and are able to regulate the outcomes of their activities (Bandura, 1986). In fact, students have the ability to symbolise, plan strategies, learn through indirect experience and self-reflect. For Bandura (1986), self-reflection is a bulging capability of social cognitive theory. Therefore, self-reflection allows students to make sense of their involvements, discover their perceptions and opinions, participate in self-evaluation, and alter their thinking and behaviour accordingly. Strategies that increase well-being, contribute by improving emotional, cognitive, motivational processes and behavioural competencies, thereby varying the circumstances under which conscious students learn (Schmidt & DeShon, 2010). By applying social cognitive theory as a basis, supervisors and facilitators could progress their students' emotions, precise their wrong views and ways of discerning, increase their theoretical skills and self-regulation (behaviours), and modify the environmental factors, to confirm student achievement.

2.3.4. Emotional arousal

Bandura (1997) confirms that students obtain self-efficacy evidence from physiological arousal, such as anxiety and stress. Strong expressive responses to a task deliver experiences about an expected success or failure; for example, if students experience bad feelings and doubt about their abilities, such as feeling anxious when discerning about talking in forward-facing of a large assembly. Those emotional responses can lead to adverse decisions of an individual's aptitude to achieve the tasks, which generate additional anxiety and worry that confirm the insufficient performance they dread. Other scholars expand upon this definition by arguing that individuals perform in the way they implement their original principles (variation in motivation under different goal structures); therefore, self-efficacy functions as the continuity or the fulfilling of initial beliefs (Wood & Bandura, 1989; Bandura, 1997; 2012). Having confidence is very important. An example is a student, who has a high ability and considerable experience in making graphs, but does not have self-assurance to generate a high quality graph for competition posters, or a significant meeting. Compare the above-mentioned student with another student, who has just regular aptitude and slight practice in making graphs, but trusts that s/he may work hard to make a high quality graph for the similar competition posters, or an important conference. The first student, with low SELS beliefs for graph conception, absences the inspiration to make one for the conference and informs the supervisor that he is not able achieve the task. The second student, due to the high level of SELS beliefs is highly interested, works tirelessly to learn how to generate a high quality graph, presents it during the meeting and earns a promotion.

SELS beliefs influences over the students' aptitude to learn, increase their motivation and their performance as people, will often initiate an attempt to learn and perform only those tasks for which they believe they will be successful (Lunenburg, 2011). The principle behind the self-efficacy theory is that performance and motivation, in part, are strong-minded by how effective students believe they can be (Bandura, 1982; Redmond, 2010).

As mentioned in Bandura (1997), self-efficacy is not the only effect on behaviour. Greater amounts of self-efficacy will not harvest an experienced performance, when students want the desired skills to prosper (Schunk, 1995). Wigfield, Eccles, Schiefele, Roeser & Davis-Kean, 2006) reveal that students' perception of reputation and the usefulness of learning may move their behaviour; for example, students who feel highly effective in science do not enrol in discipline that they believe are not relevant to their objective of attractive medical doctors. Bandura (1997) argues that students prefer to involve in actions that they have confidence in may result in constructive conclusions and avoid movements that they are certain of may lead to undesirable conclusions. In addition, self-regulated students tend to avoid volunteering answers during seminars and workshops, if they consider that, by doing so; their peers will socially reject them.

2.4. Operationalisation of the Conceptual Framework of Self-Efficacy to learn statistics

The present study's goal is to investigate graduate student self-efficacy to apply statistical procedures in their academic research. Alternatively, in this study, the researcher identifies how self-efficacy is predicted by some variables, such as individual characteristics (beliefs, previous knowledge, socio-demographic factors, academic factors and institutions), behaviour (attitudes toward statistics, attitudes toward the field) and environmental factors. In addition, the aspects of the student's experiences that may be improved through sharing of good practices, via feedback expertise with supervisors and peer students, will be determined. However, 'SELS beliefs' is the main variable. To reiterate, Bandura (1977) emphasises that SELS beliefs is measured by the combination of four components, namely, performance outcomes, bad learning involvements, perspectivisations and expressive inspiration. However, it is the difference between current modes of engagement and desired goals.

However, there are restrictions to student self-efficacy, such as the supervisor developing the learning tasks and determining the assessment requirements. The supervisor establishes an academic task to initiate self-regulatory processes in the student; except that the engagement with the task requires the student to build a personal interpretation of the meaning of the task and its requirements, based on previous knowledge and beliefs (Nicol & Macfarlane-Dick, 2006). The internal conception of self-regulation allows the student to frame his/her own goals (tasks). However, the supervisor's goals and those of the student's might overlap if the student is not conscious and consistent. This can result in the student building ambiguous and unclear goals (Bandura, 1984; 2012). Considering that these goals contribute to the establishment of the strategies and procedures to produce internal and external outcomes, the ambiguity will affect many other areas of the student's work (Nicol & Macfarlane-Dick, 2006). Internal outcomes refer to the variations (similarities and differences) observed in the understanding, interpreting, and reasoning, of emotional strategies, as well as the change in self-perceptions of ability, or the motivation observed during task engagement. Conversely, external outcomes refer to behaviours, as well as what students' produce, namely, essays and presentations.

Investigating these connections with the tasks, the results generate internal reactions at several levels, including the cognitive domain, beliefs, behaviour and environment (Pajares, 1996; Mvududu 2003; Perepiczka *et al.*, 2011). This response is a consequence of the difference between current modes of engagement and desired goals. However, these comparisons assist the student to consider some important questions leading to decisions, such as, "Should the current modes of commitment remain as they are, or is some type of variation needed?" For example, to help a student become more effective, this self-generated feedback needs to refine an interpretation of the task, or to adjust internal goals, procedures and plans (Fullan, 2007; Bandura, 2012). Even the revision of a student's field of knowledge, or motivational beliefs, is necessary, in case it influences subsequent self-regulation.

The reformative assessment helps students to yield control of their own learning process. Student evaluations of self-efficacy are complete through two interconnected procedures. In the first process, students link their social identities, views, feelings and abilities with others. In this process, if students feel lesser to those with whom they cooperate, their self-efficacy is negatively affected. In the second case, students measure themselves through their interactions with others. Students rate their ability, as others have confidence in them to be. If significant, others do not reason highly of a student, that particular student would come to reason poorly of himself/herself, which reflects the assessment of an individual's self-worth. Self-efficacy is correlated, strongly and negatively, to unhappiness (anxiety), as self-efficacy tends to enable an individual to cope with stress more efficiently. Therefore, to understand anxiety, one needs to appreciate the issues and procedures that contribute to reduce self-efficacy. Although there are many associates of self-efficacy, this current study emphases on individual characteristics, anxiety, behaviour and social factors.

2.4.1. Impact of background characteristics on Self-Efficacy

The respondent's characteristics represent the first factor in the model that influences SELS beliefs. Age, ethnicity/nationality, and gender are the characteristics that are often studied. Many studies investigate possible gender differences. These studies are conducted using undergraduate students (Rodarte-Luna & Sherry, 2008; Mji, 2009; Beurze, Donders, Zielhuis, De Vegt & Verbeek, 2013; Kiekkas *et al.*, 2015); however, some studies focus only on graduate students (Hannigan, Hegarty & McGrath, 2014; Williams, 2014; Abdullah, Adebayo & Talib, 2015), while the last group emphasizes both undergraduate and postgraduate students (Coetzee & van der Merwe, 2010; Teman, 2013).

Regarding *statistics anxiety* (STARS), in general, males have positive feelings, compared to females. Women report high levels on the overall STARS score and specific subscales score, including interpretation anxiety, test and class anxiety (Rodarte-Luna & Sherry, 2008; Beurze *et al.*, 2013; Teman, 2013). Females also score higher levels of the lack of Computational Self-efficacy, compared to males (Rodarte-Luna & Sherry, 2008; Beurze *et al.*, 2013). Concerning *fear of asking for help*, only one study observes positive feelings among males (Rodarte-Luna & Sherry, 2008), while no latent mean differences are registered for "*fear of asking for help*", "*worth of statistics", "fear of statistics"* teacher and "*computational self-concept"* (Teman, 2013).

Using procrastination, Rodarte-Luna and Sherry (2008) reveal that learning strategies and STARS for women differ. All the learning strategies, except *peer learning* are negatively related to all the STARS subscales. Similarly, procrastination in men is positively connected to all types of statistics anxiety. However, women are better in applying learning strategies, which affect their anxiety significantly. Concerning procrastination rehearsal, organisation and elaboration, women score close to the finding for men. In addition, for women, learning strategies like rehearsal, organisation and elaboration can have both positive and negative effects on STARS. Regarding the relationship between gender and attitudes components, five studies reveal consistent findings (Mji, 2009; Coetzee & Van der Merwe, 2010; Perepiczka *et al.*, 2011; Hannigan *et al.*, 2014; Kiekkas *et al.*, 2015). Post-test scores are reportedly higher than pre-test scores for female participants (Affect, Cognitive Competence, Difficulty, Effort, Interest and Value). In addition, significant positive correlation is found between the post-test overall SATS-36 scale score and the examination performance among female participants (Kiekkas *et al.*, 2015). Hannigan *et al.* (2014) indicate the female score as lower on all components, except "*effort"*, compared to male students. However, more females show positive attitudes (i.e., more "*effort"*) compared to their counterparts. After adjustments for *age group* and *nationality*, there are no considerable gender differences for any of the six components. Similarly, Mji (2009) establishes in his study that no statistical significant sex differences exist, while Coetzee and van der

Merwe (2010) reveal that more males have positive feelings for statistics, compared to females, except for their *affect,* where females score higher than males.

Several studies investigate connection of SELS belifs components with ethnicity or nationality. Some of them focus on graduate students, and report a substantial difference in means' attitudes across the categories of both ethnic or nationality (DeVaney, 2010; Hannigan *et al.*, 2014). Students are recognised as White, Black, Asian or other (DeVaney, 2010); Irish, Other nationalities (Hannigan *et al.*, 2014); Latino/Latina American, Asian/Asian American, Euro-American; African/African American, Native American; Middle Eastern/Middle Eastern American; Another self-classified as other (Rodarte-Luna & Sherry, 2008). DeVaney (2010) observed demographic differences regarding ethnicity and programme enrolment. More Black students reportedly study on-campus, compared to online, while more white students reportedly study online compared to on-campus.
Regarding programme enrolment, the results reveal that remarkable differences in attitude exist for the categories of both "*affect"* and "*difficulty"*. For these two categories, on-campus students are more favourably disposed in line with statistics. However, the results on the category of "*affect"* reveal that online students increase significantly from the pre-test to the post-test. The fact show that considerable differences are determined for the two attitudes' scales is not surprising. This is due to the fact that they have moderate to strong negative correlations with the emotion scales. Hannigan *et al.* (2014) reveal that Irish students report lesser than other nationalities (North American) on all components surveys of attitudes towards statistics. Since the definition of ethnic or nationality varies across researches, there is a great difficulty to generalise these outcomes.

Four studies inspect the relationships between student age and component scores for statistics anxiety (Mji, 2009; Coetzee & Van der Merwe, 2010; Beurze *et al.*, 2013; Hannigan *et al.*, 2014), while three studies investigate the relationships between student age and the component scores for attitudes towards statistics (Mji, 2009; Zhang *et al.*, 2012; Hannigan *et al.*, 2014). Younger students have more positive attitudes towards statistics, than older students do. The effect for age difference was not considerable within STARS. Hannigan *et al.* (2014) established that older students tend to score lower compared to younger students do on all components, except the "*interest"* subscale. Being older is a significant predictor of "*difficulty*", after adjustment for gender, nationality, whether or not a quantitative course had been taken in their primary degree, and rating of performance in mathematics.

In contrast, a negative relationship was observed between age and above components. Zhang *et al.* (2012), concerning clinical academic specialties, found a positive effect on SATS. This implies that students with clinical academic specialties are likely to have a negative attitude compared to their counterparts. Futhermore, many continents, namely, Africa (i.e. South Africa), Europe, America and Asia impact these researches; therefore the nationalities of the students involved are different. As a result, these findings cannot be generalised. Abdullah *et al.* (2015) indicate no mean difference in the sociocultural adjustment, founded on the year of study and marital status among international graduate students at a Malaysian university.

As far as previous experience is concerned, three studies examine the relationship between this variable and the attitudes towards statistics (Coetzee & Van der Merwe, 2010; Zhang *et al.*, 2012; Hannigan *et al.*, 2014). No statistical mean differences are observed, indicating no significant correlation between ATS and the number of years that students had studied Mathematics at high school; or the difference of previous Mathematics or statistics courses they had taken at university (Coetzee & Van der Merwe, 2010). Zhang *et al.*, (2012) observed high scores on the "*affect*" and "*cognitive competence*" subscales, which reveal that students had positive emotions towards statistics and had basic knowledge and skills when they learned and applied statistical procedures. Research experience predisposed students to more positive attitudes. Students with a better Mathematics basis, had more positive attitudes, compared to their counterparts with a poor basis in Mathematics. Hannigan *et al.* (2014) suggest that prior performance in mathematics is a strong predictor of the five ATS components, except "*effort*".

Regarding *statistics anxiety*, Beurze *et al.* (2013) observed that experiences in statistics did not influence the STARS scores while prior mathematics in high school connect, with a lower score on the STARS. Nevertheless, Performance in mathematics from high school is meaningfully linked with STARS outcomes. Similarly, Freng, Webber, Blatter, Wing and Scott (2011) examine the relationship among the timing, the both previous statistics and research methods, and the research performance at the postgraduate level in psychology. Results of multiple regression reveal that the timing, the both previous research method and statistics contribute significantly to predict the research outcomes at the postgraduate level in psychology as a full model. In addition, Freng *et al.,* (2011) repeat the same test. The number of Psychology courses completed and the average score for previous statistics/research methods, contribute significantly to the model. Unfortunately, the timing of the methodology course completion is not significant. Early enrolment and prior achievement in statistics and research methods predict the completion in graduate psychology courses. These factors are linked to the psychology performance at the postgraduate level.

Moreover, the respondents' demographic information such as age, ethnicity/nationality and gender differed based on their emotions, behaviours and social support at the assessment time. Another important variable contributing to the variation of SELS beliefs of graduate student is statistics emotion.

2.4.2. Relationship between Statistics Anxiety and SELS Beliefs

Statistical anxiety is one of the predictors of SELS beliefs. It defines as the individual's feeling experienced when doing statistical analysis. This involves the gathering, processing and interpreting of data in any type and at any time. The Statistical Anxiety Rating Scale (STARS) is a tool to measure statistical anxiety. Finney and Schraw (2003) settled a questionnaire tool to measure self-efficacy. They found a negative relationship between SELS and statistics anxiety. The students with high level of SELS beliefs tend to have less level of statistics anxiety when achieving statistics tasks. Similarly, those with less level of SELS beliefs are likely to have high level of statistics anxiety. Hsu, Wang & Chiu (2009) report that many students completed high STARS in the social sciences. Females are more pronounced with STARS compared to males. In this study, statistics anxiety is categorised into two sub-groups, which include predisposition and enabler factors.

Predisposition factors consider previous knowledge, beliefs factors and socio-demographic factors. Enabler factors are interpersonal factors that are related to post-graduate programmes, type of study, student status and academic institutions. These enabler factors directly influence the performance, or ability of graduate students in their current programmes. Statistics anxiety contributes to the change in students' learning in an academic programme. Many studies examine statistics anxiety using undergraduate students (Bell, 2003; Rodarte-Luna & Sherry, 2008; Mji, 2009; Stalder & Olson, 2011; Beurze *et al.*, 2013; Teman, 2013; Chiou, Wang & Lee, 2014), other studies focus only on graduate students (DeVaney, 2010; Teman, 2013; Williams, 2014), and the last group places emphasis on both undergraduate and postgraduate students (Teman, 2013). Regarding the context, the majority of studies in this review are conducted in the USA (Bell, 2003; Rodarte-Luna & Sherry, 2008; Hsu *et al.*, 2009; DeVaney, 2010; Stalder & Olson, 2011; Teman, 2013; Williams, 2014); in Europe (Beurze *et al.*, 2013), in Asia (Chiou *et al.*, 2014), and in South Africa (Mji, 2009).

Concerning the research design, numerous studies apply a quantitative method (Bell, 2003; Rodarte-Luna & Sherry, 2008; Mji, 2009; Stalder & Olson, 2011; Beurze *et al.*, 2013; Teman, 2013; Chiou *et al.*, 2014; Williams, 2014), while only one research uses mixed methods (DeVaney, 2010). The Statistical Anxiety Rating Scale (STARS) is employed as an tool to measure statistical emotion. The first category completes the full set of factors of STARS (Bell, 2003; Rodarte-Luna & Sherry, 2008; Beurze *et al.*, 2013; Teman, 2013; Chiou *et al.*, 2014; Williams, 2014), while DeVaney (2010) uses only three factors of STARS, including, "*interpretation anxiety; "asking for help"; "test and class anxiety"*. However, Mji (2009) assesses STARS in a different manner by dividing the total scores for each item into low and high anxiety groups. However, Stalder and Olson (2011) assess statistics anxiety by using eleven mnemonics with four questions about each.

Bell (2003) explores statistics anxiety among undergraduate business students, and divides them into traditional and nontraditional students at a USA University. He reveals that the nontraditional students scored significantly higher anxiety on one of the factors "*test and class anxiety"* and not significantly higher on four of the remaining five factors. The only factor where the traditional students scored higher (indicating more anxiety), was "*worth of statistics"*. According to the final grades, the traditional group scored significantly higher, while the nontraditional group achieved significantly lower grades. Bell (2003) acknowledges that statistics anxiety is not the only reason of the lower grades. Other reasons may include, being absent from the mathematical environment for a period of time, and family responsibilities. In the same vein, traditional postgraduate students may also experience a low level of anxiety, compared to nontraditional postgraduate students, simply because they were using the same learning strategies, or method of study. However, the level of anxiety between undergraduate and postgraduate traditional students can be different, due to differences in age, experiences and family responsibilities. In addition, this will be applicable to postgraduate and undergraduate nontraditional students, as well. Regarding STARS, there were negative correlations between the final grades and many components of STARS. Bell (1998) found that international students significantly experienced higher level anxiety than their domestic counterparts in statistics.

In the study of Rodarte-Luna and Sherry (2008), students from a Southwestern University in America completed online surveys, using the STARS and procrastination. Descriptive discriminant analysis (DDA) and canonical correlation analysis (CCA) examine how STARS is connected respectively to the male and for female learning strategies. "*Interpretation of statistics*", "*test and class anxiety*", "*computational self-concept*", and "*fear of asking for help*", present differences in groups, with females being meaningfully more worried compared to males. Men consider that statistics has slight value, while women believe that statistics has great value. Women have higher scores on business, meta-cognitive self-regulation, and, to a certain degree, on practice, whereas men achieve greater scores on critical thinking. Procrastination, rehearsal, and organisation together, positively predict "*interpretation of statistics*", as well as "*test and class anxiety*" (Rodarte-Luna & Sherry, 2008). Rodarte-Luna and Sherry (2008) reveal that men with statistical anxiety can be assisted with tactics that will address their procrastination. This may be helpful if it can be incorporated with their study habits, which will enable them to improve their learning strategies as well as be more willing to "*ask for help*".

Women apply more learning strategies than men do, while the latter are more focused, compared to their counterparts. By contrast, men procrastinate more in their study programme than do women do. Women's reluctance to "*ask for help*" in statistics has enhanced the differences between male and female scores. However, the results of the study may be different, if more institutions are considered, if more learning strategies for statistics are explored, and if both quantitative and qualitative research methods are applied. In addition, Descriptive Discriminant Analysis makes it problematic to take a broad view of the findings.

In another study, Mji (2009) examines gender differences on anxiety and attitudes toward statistics using undergraduate students from taxation, marketing, or accounting at the South African University of Technology in the Eastern Cape. He administers the STARS, as well as the Attitudes towards Statistics (ATS) instrument, including demographic information. The assessment of statistics anxiety is divided into low and high anxiety groups, by using a median split of total scores on each of the STARS subscales. The values of internal consistency for scores on the Statistical Anxiety Rating Scale are .88 (95% CI = .86 to .90). The results reveal that among all STARS subscales, more than half of the participants in each of the three study programmes obtained high anxiety, with about two-thirds of Cost and Management Accounting on the "Fear of asking for help" subscale. The Bonferroni-adjusted subscale comparisons among means for anxiety subscales reveal that differences are mainly between students taking Taxation and Cost Management Accounting, with students of Taxation scoring higher in all anxiety scales, compared to those in the latter area. Students scored higher anxiety on items of the subscales *"Test and class anxiety"* and the *"Fear of asking for help"*. Mji (2009) suggests that, although the students scored high levels of statistical anxiety, if more students are considered across various fields of study, the level of anxiety may be different. Based on the fact that Mji (2009) uses a median to share participant emotions into two categories, the data of which are subsequently exposed to multivariate analysis, there is a need for more attentiveness in the analysis, in order to achieve accurate results.

A third study conducted at a USA University compares the level of STARS and attitudes towards statistics among students. Also, DeVaney (2010) uses mixed methods to check the differences or similarities based on the enrolment status in statistics courses. The respondents complete only three components of the (STARS) and the SATS-28 instrument, at the beginning and at the end of a course. The decrease in the completion of the second survey could not be properly addressed because the survey is anonymous. DeVaney (2010) discovers that the likely modification from pretest to posttest differs among the groups. The students with high pretest scores decrease on posttest while those students with low pretet scores increase their scores on post test.

These findings may be different if more students register on campus, which will enable them to have access to more resources, and to ask for the help from peers and lecturers "face to face". The anonymity of the participants in the completion of both surveys, and the decrease in the second survey, may explain the inconsistency observed in the DeVaney (2010) statement. It highlights that students with high pre-test scores, achieve lower in the post-test, while students with low pre-test scores, score higher on the post-test, while individuals who score around the average in the pre-test, score around the average on the post-test. Normally, if a student has a low level of anxiety in pre-test, the level of anxiety should remain low, or even lower in post-test (DeVaney, 2010; Chiou *et al.*, 2014). However, this is contrary to the result of the DeVaney (2010) study, which implies that for such an increase in the post-test should be a research topic for future investigation.

Another study at a Midwestern university in USA focuses on the importance of aides-memoires to make statistics materials more accessible for undergraduate psychology students (Stalder & Olson, 2011). The participants review 11 mnemonics throughout the semester, using four questions as follows: (a) "To what degree was this mnemonic helpful in learning this information?" (b) "Did this mnemonic make learning this information easier or faster?" (c) "Did this mnemonic make the information easier to recall during homework or tests?" and (d) "Do you recall this mnemonic from the semester?" One-sample t-test compares mean student scores against scale midpoints. The findings reveal that students significantly report as helpful, 8 of the 11 mnemonics, by using the three-item helpfulness measure. Half the sample of respondents report the 3 remaining aides-mémoires' perceived helpfulness ratings to significantly exceed the scale midpoint. For the overall use of statistical mnemonics, other measures reveal a relatively high rating. Stalder and Olson (2011) suggest that mnemonics improve learning and motivation. They confirm that moderate belief of mnemonics decreases statistics anxiety. Mnemonics reduce statistical anxiety prevalence; however, the mechanisms cannot be explained. Therefore, the method of assessment is not an experimental design to clarify the change observed, and even among lecturers, misconceptions about mnemonics exist. Additionally, Stalder and Olson (2011) report a significant difference, when relating the mean rating and scale midpoint of statistics anxiety, reduction ratings, with the mean rating exceeding the scale midpoint.

Beurze *et al.* (2013) investigates statistics anxiety among medical students at the Radboud University Nijmegen in the Netherlands. First and second year medical students complete the questionnaire on Statistical Anxiety Rating Scale (STARS). There is no association between the STARS scores and the achievement in the medical professional training courses, for both the first and second year medical students. Only the second year students, who score higher on the statistics and epidemiology aspects, show lower on the STARS scores. Epidemiology courses contain many statistical aspects. Experience in statistics does not disturb the STARS scores, while poor mathematics scores during high school does connect meaningfully with high worry.

In a study conducted by Teman (2013), students at a midsized university, in the western part of the United States, complete the Rating Scale (STARS) with demographic information. The participants from various academic disciplines register in statistics and research methods courses. Teman (2013) explores statistics anxiety, using a confirmatory factor analysis (CFA) with the WLSMV estimator. Considering the component fit, all six factors are statistically significant for both sexes, indicating that the model appears to be appropriate for both men and women. A factorial invariance analysis assesses the configural invariance. However, latent mean differences concerning males and females for both the "*Test and class* anxiety" and the "*Interpretation of statistics*" are statistically significant, revealing that women experience higher anxiety in those areas, while the contrary occurs in the four remaining factors for the men and women. Regarding the invariance analysis of the students' education level, undergraduate students fit adequately; however, the test of latent means was slightly lower than required. Therefore, graduate students fit well. Estimates of all parameters are statistically significant for both groups. Teman (2013) advises that further inferences of the invariance of the thresholds, include the validity of between-group comparisons made for sex. If the researcher compares the observed or latent means of the two groups, an independent-sample t-test would be meaningful and readily interpretable, as a true mean difference.

In 2008, a study reveals that deprived communications among mentors and learners is the key motive for statistics worry. It encourages learners to communicate their greatest significant queries to instructors, using a *one-minute paper* strategy (OMPS) (Ruggeri *et al.,* 2008). To further the research, Chiou *et al*. (2014) evaluates the efficiency of a

OMPS to reduce the students' anxiety. The study applies the quasi-experimental design with one pre-test and two post-tests. Learners in both categories receive identical information and worry, earlier to the time of directing the OMPS. Practical outcomes show that the OMPS expressively improves learning success, and expressively reduces worry of learners at together the post-tests. In addition, the average variations in knowledge outcomes reveal that the experimental group has improved learning achievement over time. Chiou *et al.* (2014) established that the OMPS meaningfully diminishes learners' statistics worry and improves learners' statistics knowledge accomplishment. Besides, most students believe that the OMPS is a dominant rereading instrument to rearrange main ideas and make used for examinations. The improvement occurs at two stages including students' attentiveness in probing queries and the eminence of instruction through consistent student-teacher connections. Chiou *et al.* (2014) assume that OMPS reduces students' anxiety by reviewing lessons, which enable them to record their problems for consultation in the next class and reorganise main points for examination preparation. They also agree that empirical results may be influenced by the differences in student mathematical ability.

In a later study, conducted by Williams (2014), graduate students with different majors at a South Western University in USA completed the Statistics Anxiety Rating Scale (STARS), the Self-Description Questionnaire III (SDQIII), the Preference for Numerical Information Scale (PNI) and their demographic background. The findings revealed that four componentss of STARS ("*worth* statistics", "*computation self-concept"*, "*interpretation of statistics"*, and "*test and class anxiety"*) were strongly related to PNI with a strong effect size. The PNI indicated a strong association with mathematics self-concept; or greater PNI was related with greater mathematics self-concept, which confirmed the validity of the PNI. The results revealed that a higher PNI was related to lower statistics anxiety among graduate students. All of the instruments of Williams' (2014) study were self-reporting and, therefore, subject to subjective bias.

Evidently, statistics anxiety has been explored for years; however, there are very few studies in which the authors first assessed whether the validity of the scores from STARS are equivalent across different sub-populations. Therefore, valid scores comparisons across different sub-groups are confusing. Mean differences in statistics anxiety, across different groups, could be seen as a measurement of items, rather than real differences in perception of statistics anxiety, without measurement equivalent (Hutchinson, Raymond & Black, 2008). If there is no measurement equivalence across comparison groups, it is possible that prior research results are inaccurate, because the assumption of equivalent groups is incorrect. This issue could be a priority for a new investigation, to evaluate the cross-cultural comparability of STARS, because absence of measurement equivalence implies that sub-group responses are not meaningfully comparable.

In addition, it turns out that in the social sciences, all graduate students are expected to consider statistics as a portion of their educational preparation; however, this is not always the case. Prevalence of statistics anxiety is not only due to poor, or to inadequate expertise, but also because of some external factors, or previous negative experiences.

2.4.3. Relationship between Attitudes towards Statistics and SELS Beliefs

In this current study, "attitudes toward statistics" is defined as a combination of the students' "attitudes towards the statistics course" and the students' attitudes toward the use of statistics the field of study (Cashin & Elmore, 2005; Wise, 1985). However, according to Gal and Ginsburg (1994), they report that students frequently come in statistical courses with adverse opinions, or far along mature adverse attitudes towards statistics. "Attitudes toward statistics" include four components ("*affect"*, "*cognitive competence", "value"*, and *"difficulty")* – while "attitudes toward the field of study" comprise only two components *("interest"* and "e*ffort")*.

However, conflictingly, Wise (1985) observed that the students' negative SATS score achieve low performance in statistics courses. For some students, statistics is considered a barrier to obtaining their degree (Galusha, 1998; Rose, 2005; Fleiss, Levin & Paik, 2013). This current study addresses the change observed in attitudes toward statistics of the students, given that the Survey Attitudes Toward Statistics (SATS) data are linked to student performance measures and other student characteristics. In addition, a possible investigation of the relation between attitudes and performances, as well as, academic and demographic predictors of current attitudes and changes in attitudes, according to the desired expectations (goals), is also conducted. Additional well-meaning attention is given to how attitudes towards statistics may influence students' self-efficacy in learning statistics, in their academic environment.

“Attitudes towards statistics” have been explored by several studies, using undergraduate students (Evans, 2007; Chiesi & Primi, 2009; Zimprich, 2012; Hagen, Awosoga, Kellett & Dei, 2013; Swanson *et al.*, 2014; Kiekkas *et al.*, 2015). Other studies focussed only on graduate students (DeVaney, 2010; Zhang *et al.*, 2012; Hannigan *et al.*, 2014). The last group concentrated on both undergraduate and postgraduate students (Coetzee & Van der Merwe, 2010). With regard to the context, many of these studies were conducted in the USA (Evans, 2007; DeVaney, 2010; Griffith *et al.*, 2012; Swanson *et al.*, 2014); in Europe (Chiesi & Primi, 2009; Zimprich, 2012; Kiekkas *et al.*, 2015), in Canada (Hagen *et al.*, 2013); in China (Zhang *et al.*, 2012); and in South Africa (Coetzee & Van der Merwe, 2010; Mji, 2009). Considering the research design, numerous studies applied the quantitative method (Chiesi & Primi, 2009; Mji, 2009; Coetzee & Van der Merwe, 2010; Zimprich, 2012; Hagen *et al.*, 2013; Hannigan *et al.*, 2014; Swanson *et al.*, 2014; Kiekkas *et al.*, 2015), while only three studies used mixed methods (Evans, 2007; DeVaney, 2010; Zhang *et al.*, 2012), and one research applied a qualitative method (Griffith *et al.*, 2012).

The Survey Attitudes Towards Statistics (SATS) was applied as the instrument to measure statistical anxiety. The first category completes the full set of factors of SATS (Coetzee & Van der Merwe, 2010; Hannigan *et al.*, 2014; Swanson *et al.*, 2014; Kiekkas *et al.*, 2015), while some scholars (DeVaney 2010; Zhang *et al.*, 2012; Zimprich, 2012) used only four factors of the SATS instrument, namely, Affect, Cognitive competence, Value, and Difficulty. Chiesi and Primi (2009), as well as Mji (2009), however, used the Attitudes Towards Statistics (ATS) scale, while Evans (2007) assessed the general attitudes towards statistics, by using eleven mnemonics, with four questions about each.

The students, who were randomly selected from three departments at the United States University, regardless of having general positive attitudes, still pronounced selected negative “attitudes toward statistics” (Evans, 2007). Certain students usually considered statistics to be a well-meaning part of study, as well as a substance in which they believed they could complete adequately. Nevertheless, additional students considered statistics to be a subject they would rather not be studying at the time, because they deemed it unnecessary in their individual professions. The last group of students believed that statistics was not a convenient subject for them, but, precisely for others.

In addition, Evans (2007) interviewed five instructors at the end of the semester, using open-ended questions to explore the strategies that the instructors were applying to progress the attitudes, and remove the misconceptions, of their students. One mentor established the connection among statistics and upcoming courses the students might learn. Additionally the mentor used humour, confidence, and eagerness for statistics to produce extra attention. In addition, one instructor asked students to collect data, using a survey on the opinions of a future governmental appointment. This presented as a real-world illustration to support students to acquire a good understanding of statistical conceptions, and their real-life applications. This additional facet of data assemblage permitted students to practice their individual records for statistical examination.

A second study, conducted at the University of Florence, Italy, focussed on undergraduate psychology students' measures and attitudes in the Italian educational context (Chiesi & Primi, 2009). In this study, 313 psychology students at the university completed mutually pre-course versions of the SATS and ATS, while only 263 completed jointly post-course versions of the SATS and ATS. A multivariate analysis established the unchanged time of the SATS instrument. Chiesi & Primi (2009) revealed that the pre-SATS and the post-SATS results in their study have different structural weights. The pre-SATS result showed that, as the original SATS scores upgraded, the closing grade augmented with a small magnitude. However, the post-SATS result designated that as the last SATS improved, the final grade also increased with a big magnitude. The hidden difference in means among pre- and post-administrations indicate that the changes for all components were positive values and statistically meaningful. Given that the achievement is measured through written and verbal examinations, they establish that there is a correlation, among college students, between a positive "attitude toward statistics" and achievement in statistics examinations. Therefore, the approaches at the close of the subject were a better prognosticator of attainment than the behaviours at the opening. Once they attended the classes, the students were inclined to be extra self-assured in their academic awareness and expertise, when applied to statistics, while the attendance of the courses moderately condensed the apparent struggle of the statistics subject.

Mji (2009) reports no statistically significant gender differences for the attitudes towards statistics courses, while there are statistically significant differences for the area of study programmes. Bonferroni-adjusted subscale contrasts among averages for attitudes components revealed that the variances were mostly among students studying Taxation and Cost Management Accounting. In addition, a substantial difference was indicated on the subject attitude component concerning the similar clusters. He argued that Taxation students had more adverse approaches towards statistics courses, compared to those in the other two areas (Marketing and Accounting). Students in Taxation recorded negative behaviours about statistics, especially within their area of study. This may be related to their previous experiences with statistics, given that they did not have previous knowledge of mathematics. Self-reports from respondents during data collection, reliance on oral materials present at meetings, or still unpublished researches, restrict occasions for more wide evaluations, and limits several forms of reliability, as well as validity of the instrument.

Ciani, Easter, Summers and Posada (2009) investigated how the autonomic arousal and statistics self-efficacy of undergraduate students could positively affect their scores in final examinations at a Midwest University in the USA. Important Pearson connections were observed among physiological arousal and self-efficacy, as well as among self-efficacy and positive "affect". Using artificial cut points (for example, average differences), Ciani *et al.* (2009) examined interaction effects and revealed a substantial positive key result of self-efficacy on positive behaviour. Once incoming the collaboration term, the leading result of self-efficacy was still important, and the communication term was similarly important for effect. These researchers, therefore, argue that students with high confidence have higher positive behaviuors, while students with low confidence have lower positive behaviours, as autonomic arousal increases, when they are aware of the imminent final exam. Students with low self-assurance may tend to misinterpret their autonomic stimulation as negative; and the adverse behaviour that follows may damage their aptitude to concentrate on the assignment at finger. The results indicate that increased physiological arousal of students is correlated to increase self-efficacy beliefs. In addition, at moderate-to-high levels of self-efficacy, strong reports of arousal correspond with strong reports of positive behaviours, while at low levels of self-efficacy; there is an opposite association between the strong of physiological arousal and positive behaviour.

Regarding the results of SATS for American students enrolled statistics courses, achieved a substantial difference for the "*affect*" and *"difficulty"* by DeVaney (2010). The on-campus students have more favorable SATS while online students increase considerably on Affect from the pre-test to the post-test. An "independent sample t-test" reveal substantial modifications among the on-campus and online students for two SATS components *"affect"* and *"difficulty"*. The choice and assignment criteria would have affectedly lead deterioration to the mean.

In a study conducted by Coetzee and Van der Merwe (2010), a sample of UNISA undergraduate and graduate psychology students were selected, using a convenient sampling method. They applied a cross-sectional survey design to examine the reliability and validity of the "Survey of Attitudes Toward Statistics" (SATS-36). In addition, they investigated the variances regarding students' SATS scores, in terms of their previous mathematics knowledge, levels of statistics courses, and biographical variables (Coetzee & Van der Merwe, 2010). All the latent components, excluding the "*difficulty"* factor, attained suitable levels of internal reliability, which implied that the "*difficulty"* factor did not describe the data sufficiently. More students likely disagree with the item, "Statistics procedures are easy to comprehend", or less students agree with the item, "Statistics is a complicated subject". The Mann-U Whitney test revealed no important change between the levels of statistics courses and the students' SATS scores.

Doctoral and master's students, in various colleges of education, at 250 universities in the USA, participated in the study lead by Perepiczka *et al.* (2011). The main objective was to evaluate how these students in counseling and education, from different backgrounds, react to statistics courses, as well as the implications for their educators. The authors investigated the connection among self-efficacy to learn statistics SELS) and statistics anxiety (STARS), attitude towards statistics (SATS), and social support (MSPSS) of graduate students. The study employed a quantitative method. STARS and SATS were extremely interrelated, demonstrating multi-collinearity. The results from the various instruments revealed negative correlations concerning SELS and STARS, as well as positive correlations between SELS and SATS. The findings of multiple regression analysis indicated a statistically important association among SELS and STARS, SATS, and MPSS, with a modest influence magnitude at 52.8% of the variance accounted for in the model, $R^2 = .528$. Additionally, MSPSS did not impact the analysis, removing it in the model did not change the result. STARS and SATS are meaningful predictors of SELS.

Griffith *et al.* (2012) investigated an illustration of undergraduate students from two universities in the USA indicated that student attitudes toward statistics are either positive or negative, and the reasons for their attitudes were given in the written format. These respondents were students with criminal justice, business, and psychology field marshal. The business major students were the most positive, compared to criminal justice and psychology major students. For positive attitude toward statistics, the business major students tended to have confidence in that indicators were useful in their upcoming profession. However, an interconnection existed among study's field and behavior components. The business major students presented more frequent responses compared to criminal justice and psychology major students. For graduate school, more psychology major students have recurrent responses, other major students. Business major students seemed to ensure a better appreciative of the prominence of statistics in their coming profession, whereas psychology major students were inclined to have conviction that statistics was significant for graduate school.

The respondents with negative attitudes of were grouped in five categories across the majors. Business students achieved with fewer responses while their countermates were more pronounced. In addition, criminal justice and psychology students, considered careers that were more in line with their mindsets, and there was no connection of statistics in the field they intended to follow, while business major students required more of a considerate of statistics requests in businesses. Useful information may have been acquired if the students were assessed in a pre/post-tests manner, by discipline. Additionally, the respondents were from six classes, with six different lecturers, across two universities, implying that the lecturer's background and mode of teaching could also influence the attitudes of students towards statistics. Therefore, future research should explore the influence of the lecturer's background and mode of teaching on the statistics behaviours

Zhang *et al.* (2012) directed postgraduate medical students to complete the both pre-test and posttest of the SATS-28 in a single institution in China. They explore the respondents' feelings towards statistics and its effect on students' achievement, as well as differences across departments. The findings revealed that students with greater levels of statistical instruction and research experience were inclined to have extra positive SATS. Students with a improved mathematics foundation were also extra positive compared to those with a deprived foundation. However, students with clinical academic specialties were more likely to have negative attitudes, compared to their counterparts. Therefore, students with more positive SATS had a tendency to achieve well in the examination. The "Affect" and the "Cognitive Competence" components were strongly and positively connected one to another.

Regarding the qualitative question about the basis of the overall SATS, most of the students' behaviours derived from their prior experiences in statistical or mathematical courses. Some students presumed that statistics was a portion of mathematics, and, therefore their behaviours toward mathematics were just shifted to statistics. Additional causes of influence included classmates'. In addition, the students revealed other diverse causes, such as out-of-school lives. Ultimately, more real involvements are required to assist students overcome their fear and anxiety of statistics.

Undergraduate psychology students from the University of Zurich in Germany completed the Survey Attitudes Towards Statistics (SATS) scale, German version (Schau, Stevens, Dauphinee & Del Vecchio, 1995), and wrote a statistical test (Zimprich, 2012). These resulted in the determination of the factorial structure, predictors and outcomes of the SATS. To compare the relative fit of models, the χ^2 difference test was applied, and completed by 90% "root mean square error of approximation" (RMSEA) of confidence intervals. The factorial structure of the SATS revealed that Model A achieved an acceptable fit according to the RMSEA, but not according to the χ^2 difference test. The Comparative Fit Index (CFI) indicated that the model could be improved. Model A did not adequately describe the associations between Items 10 and 19 (referring to the usefulness of statistics in professional life) or by contrast, Items 14 and 21 (referring to relatively strong negative emotions caused by statistics). In Model B, the two residual co-variances are assessed (Items 10 and 19 and Items 14 and 21). Model B completed significantly better than Model A; therefore, the

CFI was suitable. Model B was an adequate description of the data. Items 10 and 19 were both elements of the *"value"* factor, while Items 14 and 21 were elements of the *"affect"* factor. The two residual co-variances did not change the structure of factors. All factors were significantly associated, with the strongest correlation between *"affect"* and *"cognitive competence"*, and a moderate correlation between *"value"* and *"difficulty"*. Zimprich (2012) revealed that students with more positive emotions toward statistics, as well as those feeling more experienced in statistics indicated higher accomplishment.

In the Model D, there was a small impact for the difficulty of statistics, revealing that female students considered statistics to be more difficult, compared to their male counterparts. The attitude toward statistics was positively associated with mathematics grade, indicating a good performance in mathematics grade was associated with a more positive SATS. The statistics achievement was included as a latent variable; the regression was statistically significant and positive with a large effect size. Students with more positive SATS succeeded in statistics. In Model E, the four factors of attitudes toward statistics represented 30% of the variance in statistics achievement, with the strongest predictor being "Affect", followed by "Cognitive Competence", and "Value". Notably, the effect of "Difficulty" on statistics achievement was negative and strong, as well, indicating the presence of suppression, as they were bivariate positively correlated. Compared to other research domains addressing subjective and objective perspectives on performance (Mascherek & Zimprich, 2011), the link between SATS and "statistics achievement" was relatively strong. An investigation into the relationship between SATS and "statistics success" should produce more interesting insight, considering that SATS and "statistics achievement" change over time. Therefore, the changes observed in the two variables were strongly correlated. These hypotheses should be examined using latent change models.

In a study conducted by Hagen *et al.* (2013), nursing students at a university in Western Canada completed pre- and post-surveys, in order to determine their attitudes towards statistics courses, as well as complete fear and anxiety. These students also define their preferred "learning and teaching styles", and the perceived utility and value of taking a statistics course. Using a pre-experimental research design, the authors assumed that the data set denoted effective couples of the similar group of students to avoid bias, and the data set was approximately normally distributed. The nursing students described modest levels of emotions towards statistics subjects, reasonable ability in applying mathematics, and fair self-assurance in using computers for statistics (Hagen *et al.*, 2013). Regarding the preferred learning styles factor, the students seemed convinced that what they did not achieve at the beginning, would enable them to learn during the course. According to the preferred teaching styles factor, the students had favourable opinions towards their instructors, who took into consideration perfect descriptions, practicality, persistence, in-depth knowledge of statistics, thorough monitoring of the course, and appropriate feedback to students, as well as clear learning expectations.

Hagen *et al.* (2013) achieved a surprising result, when the students' fear and anxiety scores were decreased. However, the post-test results revealed the intense variation, compared to the pre-test. The students achieved some significant changes in favourites around "learning styles", among the pre-test and the post-test of the course. The majority of them also registered a positive experience with the "team-based" knowledge method used in the course. The preferences for "teaching styles" had the lowest improvement of all the student behaviours by the termination of the course. While most behaviours remained unchanged, the "instructor teaching styles", which appeared very significant to the students at the preliminary of the course, decreased rather in significance by the conclusion of the course. This study was conducted in a particular area, with a single programme (nursing), using a few respondents, and as a result, generalization might not be possible. The changes between the pre-test and post-test were difficult to explain, because of elements in the research design, such as the lack of randomization and the use of a control group, which made the study susceptible to various threats, such as internal validity, and many other details for the variations observed over time. Some changes observed among the variables in the pre-test and post-test were statistically significant, though these variations were negligible, which could make it meaningless to nurse educators in the teaching of statistics to students.

Hannigan *et al.* (2014) explored SATS among students from various backgrounds, at a medical school in Ireland. The respondents completed the survey including the demographic information, as well as the prior learning experiences section, at the beginning and end of the course. Cronbach's Alpha indicated perfect reliability. Using linear regression, the results revealed that the prior performance in mathematics remained a strong predictor of SATS constituents, except for “Effort”. Age was a significant predictor of “Difficulty”.

Hannigan *et al.* (2014) suggests that the more students undertake quantitative courses, the less such students experience difficulty. Also, they have more positive attitudes towards statistics. Similarly, the better the students’ have experience, mathematics the more positive their attitudes towards statistics. Statistics is a sub-field of mathematics; therefore, statistics educators need to place greater prominence that could improve students outcomes. Organising the instruction, conceptualising the curriculum, emphasising the application of statistics procedures and interpreting data, may bring better outcomes for students.

Swanson *et al.* (2014) investigate the traditional curriculum using the undergraduate students from different institutions in the USA. The respondents achieve both the pre-course and post-course items of SATS. The researchers used the randomization-based curriculum with a mixed methods design to compare the results of Schau and Emmioglu’s (2012) research study for US Stat 101 students, who had experienced the traditional curriculum. Based on the same criteria as Schau and Emmioglu (2012), the Cronbach’s Alpha of all the subscales of SATS indicated appropriate reliability. Swanson *et al.* (2014) reported that no published results on students’ attitudes in a randomisation-based curriculum had existed in literature before that date. The results revealed a slight improvement in the affective feelings towards statistics, and the cognitive competence of these students, with both the randomisation-based and traditional curriculum. The students indicated better reports in the post-tests. In addition, students in statistics reduced their effort set slightly, decreased their interest, and depreciated the value in it. Regarding the instructors, significant variations were observed. The randomisation-based curriculum indicated changed scores, compared to the traditional curriculum; however, these changes revealed no statistically significant differences. Although the consistent improvement that occurred in some areas of the conceptual understanding represented a gain for students from a randomisation-based curriculum, the increase in difficulty impaired students differently in their randomisation-based curriculum.

Undergraduate students in a Greek Nursing Department institution participated in a study lead by Kiekkas *et al.* (2015), using a quasi-experimental pre-test and post-test design. The researchers investigated the association between nursing student attitudes towards statistics and their performance, as well as the impact of a biostatistics on their attitudes. The results indicated significant positive and weak correlations among the post-test overall SATS components, and the examination performance. Similar findings were achieved among female participants, who were in the fifth semester of their studies. The female participants illustrated more positive behaviours after the course, which may be ascribed to the low number of male contributors, which did not permit the recognition of substantial growth. However, the Greek version of SATS-36 scales was not authenticated prior to its use in this study; while the internal reliability and only the construct validity of the Greek version were assessed in this study.

Towards the end, some factors of knowledge and instruction, which decreased statistics emotion, reduced interest in statistics and facilitated its understanding and use, were investigated through undergraduate and postgraduate programmes. The demographic variables (age, gender, ethnicity), academic variables (semester of studies and mathematical background), had to be explained, in terms of their influence on the SATS, as well as how these factors affected the connections of these behaviours with examination achievement. However, the repetition of this study, using a multi-centre design, as well as the enrolment of large student samples from various institutions, is preferred to ensure a high generalisability of the findings. In addition, a multivariate analysis is required to assess for independent associations between the attitudes toward statistics and performance in the examination of biostatistics courses, as well as to identify connections between SATS and other predictors of examination achievement.

Existing studies recognised and assessed SATS in undergraduate students; however, few focus on postgraduate students (Zhang *et al*., 2012; Hannigan *et al.*, 2014). Postgraduates have different characteristics, such as age, marital status, nationality, gender, type of study, backgrounds, and experiences in research and statistics. To appreciate each variable held by postgraduate students, regarding statistics, a cross-sectional survey was conducted. The examination of the associations between these variables, with their self-efficacy beliefs, as well as monitor their expected changes, may contribute to a reduction in student negative attitudes about learning statistics and improving their knowledge.

2.4.4. Relationship between Social Support and SELS Beliefs

The component social support is considered to be the support that an individual perceives to have accepted from supervisors, friends, family members, and "significant others" (Zimet, Dahlem, Zimet & Farley, 1988). However, this variable may have some potential influence on other independent variables, such as attitudes and anxiety (DeBerard, Spielmans & Julka, 2004). Generally, social support has a beneficial effect on the comfort of student under stress. Even when the social support is less accessible, it contributes to moderate the distress.

Multivariate analysis is utilised to build a model that determines the factors, which significantly predict the student's self-efficacy to understand/interpret statistical procedures. A multiple regression is applied to determine the variation, observed in the dependent variable (self-efficacy), could be explained through the influence created by the independent variables (individual characteristics, behaviour and social support).

Existing literature on the social support of SATS is particularly limited. O'Reilly, Ryan and Hickey (2010) explored the short-term "psychological well-being" and "sociocultural adaptation" among intercontinental students from various departments at a University in Ireland. The study applied both qualitative and quantitative methods. Using the Multidimensional Scale of Perceived Social Support (MSPSS), the outcomes revealed that intercontinental students achieved great levels of social support, indicating that they were going through many difficulties, such as using the transport system on their arrival in Ireland; however, these results decreased with time. Paired t-tests revealed significant differences in social support scores across time for international students, but between 6 and 12 weeks after arrival, there was no significant difference. Additionally, international students had significant higher levels of social support compared to local Irish students.

Intercontinental undergraduate students at a Malaysian public university involved in a study conducted by Yusoff (2012) completed the General Self-Efficacy Scale, the MSPSS, the Satisfaction With Life Scale, as well as their demographic background.

The study applied a cross-sectional methodology with a suitability sample. Yusoff (2012) used "Pearson Product-Moment Correlations" to assess how "self-efficacy" and social support factors contribute to the level of the "psychological adjustment" of international undergraduate students. The self-efficacy variable accounted for 61.04% of the entire variance. Similarly, all the questions followed the same trend on the self-efficacy instrument. The combination of support from "friends" and "significant others" was applied in this study. The support from *"friends"* and *"significant others"* factor explained for 63.75% of the whole change. All questions clearly described the social support from *"friends"* and *"significant others"*. Support from family had four items that explained for 29.52% of the total variance. In addition, "psychological adjustment" was significantly related with greater levels of support from *"family members"*, as well as greater levels of support from *"friends"* and *"significant others"*. Additionally, "psychological adjustment" and "self-efficacy" had a strong and positive connection.

In general, the regression model was statistically meaningful. Of the three independent variables investigated, "self-efficacy" and support from *"friends"* and *"significant others"* had important positive effects on "psychological adjustment". Based on the beta value, support from "friends" and "significant others" achieved the greatest coefficient of regression than "self-efficacy". High "self-efficacy" probably enabled students to approach difficult circumstances, with worry or misperception. This high "self-efficacy" likely helped them to believe that they had the self-assurance to deal with educational circumstances and difficulties. Yusoff (2012) suggests that intercontinental students with greater levels of "self-efficacy" reveal greater levels of "psychological adjustment". In addition, students, who experience higher levels of support from *"friends"* and *"significant others"*, were likely to experience more "psychological adjustment" in the university. This is because they relied on their *"friends"* and *"significant others"* for their social collaboration and needs. The regression results indicate that "self-efficacy" and support from *"friends"* and *"significant others"*, significantly contributes to the level of "psychological adjustment".

Another study, conducted at a Malaysian public university, focused on international postgraduate students, from various programmes in the faculty of educational studies (Abdullah *et al.*, 2015). The study applied a mixed methods research approach. The researchers employed a random sampling method, using the fish bowl technique to select the participants. Their aim was to explore the association between demographic information, the sociocultural adjustment, and the social support factors of respondents. The results denoted that international graduate students suffer moderate levels of behavioural adjustment difficulties, which refer to a reduction in their ability to learn, understand and adapt to a new environment. Abdullah *et al*. (2015), suggest that sociocultural change in a social learning context means socialising with the residents. However, no substantial change was perceived in the adjustment process. Regarding the open-ended question, international graduate students undergo the specific adjustment difficulties that are reduced actions such as making friends, lodging, nutrition, occupation, communication, transportation, and climate.

The regression outcomes indicate that support meaningfully predicts sociocultural adjustment among international graduate students. Therefore, a unit variation in social support will provoke about the variations of .26 units in sociocultural adjustment. Abdullah *et al.* (2015) suggest that social support from the *"family members"*, *"friends"* and *"significant others"* is an vital predictor of "psychological adaptation", throughout cross-cultural changes for international graduate students in Malaysia. Therefore, it is imperative that qualitative research about sociocultural change and social support of intercontinental graduate students is conducted in future research studies.

2.4.5. Effect of Feedback Adjustments on the SELS Beliefs

Making judgments about the value of students' information to meet a supervisor's standards or expectations implies analysing student feedback to improve the level of SELS beliefs. Concerning the external feedback, the supervisor, a peer or other means, such as computers, may provide the support. Romero and Ventura (2007) and Harris *et al.* (2009) argue that computer-based instruction helps students to learn different ways of representing data sets. This could allow the researcher to observe differences and similarities in misconception indicators of ability among students, in terms of their *student status*, *type of study*. Similarly, instructional software enables them to understand abstract ideas, such as developing understanding and interpretation (self-regulation) of concepts, or statistical procedures (Garfield & Ben-Zvi, 2009). Consequently, students actively understand, construct, raise new meaning and internalise the supervisors' feedback; this would generate an important improvement on learning process (Nicol & Macfarlane-Dick, 2006). When the supervisor analyses the performance of students in statistics, it contributes to the improvement of learning statistics. Graesser *et al.*, (1995) argue that students need to reproduce the feedback they have received and make corrections and adjustments accordingly.

The evaluation of student projects is another way of presenting perceived patterns to students, while they work on specific issues, during the academic programme; not as a last judgment of the thesis (Garfield & Ben-Zvi, 2007). However, the assessment of self-regulation, with good feedback practices, emphasizes the seven principles in learning. These learning principles include explanation of good achievement, expansion of self-assessment, provide high quality information, motivation dialogue between teacher and peers, reassure self-esteem and incentive beliefs, update helpful information to shape teaching (Heikkilä & Lonka, 2006).

All these principles allow the researcher to measure the extent to which the misconception of questions asked; depend on statistical understanding/interpretation. In addition, it could be easy to check whether the students' performances, using statistical skills are related to their socio-demographic factors.

Therefore, good practice requires that rigorous standards be applied. In addition, the low student engagement, or outcomes needed to address related issues. Consequently, the student refines, or adjusts, the necessary corrections that enable his/her learning achievements to become regulated. The conceptualisation of learning processes as a prominent role in expanding the resolutions of learning statistics in academic research. Knowledge and experiences are achieved through perceived patterns and an adjustment process for more adjustment and perfection of speculative work.

2.5. The Rationale of the Self-Regulation

Bandura (1982) emphasises that, from his findings of many studies, perceived efficacy remains a better predictor of behaviour in generalisation tests; given that behaviour is fresh data that must be intellectually evaluated for its effectiveness. Schunk (1995) concludes that self-efficacy is a major factor of individual inspiration, knowledge, self-regulation and accomplishment, while Bandura (1986; 1997) assumes that self-efficacy is predicted to fulfil human performance and well-being in numerous methods. Students with a resilient intelligence of effectiveness, set interesting objectives and uphold strong pledge to them, sustain their determinations when experience failure, and improve their level of self-efficacy after delays. However, students with low self-assurance may accept as true that tasks are more hard than they actually are; a negative belief that can substitute worry, despair, with the slightest idea of in what way greatest to end a case. The theory seems better suited to studying or learning statistics. Postgraduate students manage their academic works with minimal supervision and depend on personal aptitudes and initiatives to achieve their academic research duties. Self-efficacy is a more reliable predictor of behaviour and behaviour vary within time and space as other variables. It is closely related to the achievement of innovative expertise, and to the attainment of prior experience, at a level of specificity not found in any other stimulus ideas, which comprise probability concept. In broad, there is sufficient purpose to believe that self-efficacy is a prevailing incentive concept, which works well to expect educational self-beliefs and performances, at changing stages; but works best, when academic strategies and measures are adhered to, in terms of statistics (Pajares & Schunk, 2001a).

The concern of research question should indicate the suitable level of self-efficacy valuation in statistics. Self-efficacy beliefs measured at numerous stages of specificity reveal valuable external the research arena, as analytic and assessment tools in statistics. They can afford supervisors and facilitators with evidence regarding students' characteristics, and the results may be convenient to appreciate impacts on performances that do not simply give themselves to micro-analytic analysis.

Therefore, this current study relies more on this theory, as it provides a solid basis for an approach to answer the research questions. This study also considers qualitative information that applies an interpretive approach to assess the perceptions and experiences of students.

2.6. Synthesis and Partial Conclusion

In this chapter, the researcher situates the study within a more elaborate and detailed conceptual framework of self-efficacy of statistics learning. In describing the conceptual framework in this chapter, the researcher provides a clear picture that brings together different disciplines to promote an integrated vision of the application of statistical procedures in academic research.

CHAPTER THREE

LITERATURE REVIEW

3.1. Introduction

The statistics learning failure is not a new social and scientific problem. Many authors from business, epidemiology, sociology, public health or others disciplines have been studying the problem for several years, and investigations are still on-going (Gal & Ginsburg, 1994; Gardner & Hudson, 1999; Mvududu, 2003; Makapela, 2009; Perepiczka *et al*., 2011; Hannigan *et al.*, 2014; Kiekkas *et al.*, 2015). In this chapter, the researcher provides a synthesis of the literature about the specific point of interest defined in the objectives of this study. The aim is to review the literature on statistics learning estimates, explanatory factors, as well as their mechanism of influence, highlighting methodologies and results of existent researches that could help to orientate the study better, while using the information to enhance knowledge on the subject. Once the scientific shape has been established, the researcher explores the scientific expectation of this thesis by designing a conceptual and analytical framework that would satisfy the research questions of this current study.

3.2. Overview of Learning Estimates

Several methods have been developed, and well improved, to estimate learning, in general, but statistics learning, specifically, has lagged behind. Statistics learning estimates and real level are questions for debate among researchers. Such a situation constitutes a real problem, mostly in emerging countries, where there is a real lack of datasets about statistics learning, and the existent data are generally of poor quality and in need of direct or indirect adjustments (Levine & Renelt, 1991; Herrera & Kapur, 2007; Jerven, 2013). In this section, the researcher aims to explore existent methods of learning estimates found in the literature, as well as recall some existent models, including their advantages and disadvantages.

3.2.1. Recognition Prior Learning Model, late 1980 - April 1994

The Recognition Prior Learning (RPL) model emerged during the late 1980s in answer to the problem of learning (Singh, 2015). In South Africa, the RPL is applied for the acknowledgement of informal and non-formal knowledge. Breier and Ralphs (2009), Molla (2010) define RPL as a contrast of the previous and experience learning for a specified and determinations of the qualification. This may contribute to the success of recognitions toward the qualification (Werquin, 2010). The National Qualifications Framework (NQF) was introduced in the White Paper on Education and Training (Republic of South Africa [RSA]. National Department of Education [NDoE], 1995b). Singh (2015) emphasizes that the purpose of the NQF is to enable learners to be formally accredited so that they could continue education and training at higher levels, there by contributing to economic growth and development, both personally and nationally.

Diverse methods to RPL have also arisen such as credit-exchange (individual"s ability to complete certain tasks to a fixed standard), progressive (accent on the content), fundamental (individual knowledge of the smarted group sums as knowledge), Trojan horse (experimental and discipline-based knowledge are more thoroughly consistent) (Samuels, 2013).

RPL is applied in diverse contexts, namely, "further education and training" (FET); "general education and training" (GET); "higher education and training" (HET), to adult basic education and training, and workplace-based training (Singh, 2015). RPL has three key groups including admission group (under-qualified adult learners and candidates lacking least requests for a formal learning), reparation group (semi-skilled and unemployed workers), applicants (drop formal education early and those from short programmes) (Singh, 2015).

Prior learning is frequently formless, implicit and instinctive, requiring the assessor to determine whether formal or informal experience has met a competence level, or is worthy of credit. Judgments have to be made on whether learning standards are met and competence levels achieved ("Organisation for Economic Co-operation and Development" [OECD], 2007). There is no important variation between the previous and current evaluation of acquired skills & knowledge, the change lies in the method of the assessment (Black & Wiliam, 2009). The drive of RPL is to assess the candidate's knowledge and abilities, comparing the candidate's skills and knowledge to specific principles, evaluating the candidate beside those principles, and have confidence in the applicant (Singh, 2015).

Applicant care should not be taking too lightly. Applicants should have the option to select the evaluation procedures they are convenient with (Jones, 2013). The assessment in an RPL process could comprise a preliminary step, an evalustion step, and, if need be, an appeals process. The recognition practices are mainly collective, related to the qualifications and standards recorded in the national qualifications framework. (Kraak, 1999; Singh, 2013).

South African society is unequal, due to historical causes, but the current economic environment seems to increase social inequality (Seekings & Nattrass, 2008; Bhorat, Naidoo & Pillay, 2015). The formal education system is struggling, particularly, to provide quality education and training to all citizens (Fullan, 2007; Sahlberg, 2007). Unemployment comprises 30 to 40 per cent of the population (Blom, Parker & Keevy, 2007). However, education has a great role to play in increasing employability (Tomlinson, 2008; Bentley, 2012). According to Singh (2015), there are serious recognition, validation and accreditation issues.

Though regulation and strategies are in place, and there are regions of moral practice, the main challenge is to implement the RPL on a large scale. The strategic context should address the relevant issues including expansion of suitable policies; advance a national RPL association as a mechanism for ensuring and measuring progress; create a single, unified system of FET and HET through regulatory and planning mechanisms that encourage programme-driven interaction; create possible funding instruments; improve a broader series of credible RPL evaluation approaches and instruments.

Actually, there is no official complete funding for RPL in South Africa. In terms of estimation, the national policy recommendation is that RPL amenities should not budget more than a regular programme (Werquin, 2007; 2010). A few of evaluation centres, concentrating on RPL, have been recognised, founded on indigenous needs, in total divergence to the urgency given to RPL in general policy. The systemic conception of hybrid formations incorporates disciplinary (Mode 1) and problem-solving (Mode 2) knowledge constructs (Kraak, 1999; Pitman, 2011).

3.2.2. OBE Model, 1994 - Present

The emergence of "Outcome-Based Education and Training" (OBET) is the result of three past backgrounds: the first was the predominance of "competency-based modular education and training" in the South African industry, after 1985. The second was the recognition of Australian and British "outcomes" reproductions in the strategy expansion effort started by the ANC and COSATU, since the early 1990s. The third was the revival of the fundamental rhetoric of People's instruction, which first emerged in the warmness of the fight, in the mid-1980s. These three backgrounds have been mixed together to create a mixture instructive practice, OBET, which has required to go beyond the fine cognitive boundaries of ability models, by including the broad-minded educational values of the People's learning. This has created a learning practice, which is at the same time fundamental in broad practice, but behaviouralist in evaluation expertise (Slamat, 2009).

Later the mid-1990s, Outcomes-Based Education (OBE) has generated the only greatest significant curriculum debate in the history of South African education. Jansen and Christie (1999) highlight that the Human Science Research Council (HSRC) has followed such an aggressive and public debate, not only on the conditions of change executed by OBE, but on the logical idea and political rights on which this model of education is based. The year 1990, was a dangerous revolving point in the curriculum debates in South Africa. A coherent and predictable strategy program for education in South Africa has been established (Jansen, 2004b). Ramsay (2009) acknowledges that the apartheid state achieved a centralised curriculum policy system, which was xenophobic, strict, narrow, unchanging and biased. The curriculum of the apartheid state was a dominant and exclusive medium for education in the schools sector. The apartheid state published the education renewal strategy and a New Curriculum Model for South Africa (CUMSA). Jansen and Christie (1999) argue that the most important curriculum actor at the time was the National Training Board, later to become known outcomes-based education.

Once the OBE idea was spread, selections of teachers were involved in working on the practical implications, through special committees at national and provincial levels.

Teachers were not involved in the conceptualisation of OBE, or in decisions about its adoption (Pillay, 2010; Boud, 2013).

However, as the development of South African OBE continued, the experts from other countries assisted in the development thereof. These experts came from Scotland, Australia, New Zealand (which has a qualifications framework debate, rather than OBE), England and the USA. However, the Spady (1995) version of OBE continued to dominate.

The shift from "competency" mind-sets to a more progressive reading of outcomes first became noticeable as an emergent discourse in the ANC and COSATU policy document of 1993, *A framework for lifelong learning*, and the January 1994 ANC policy document, "*A Policy Framework for Education and Training"* (ANC Education Department, 1994). These initial signals of a possible future pedagogical direction (using outcomes-based ET) became significantly amplified in the 1994 National Training Strategy Initiative (National Training Board [NTB], 1994) and the ANC government's "*White Paper on Education and Training"* in March 1995 (NDoE, 1995a). However, the real turning point in the rise of an outcomes-based discourse, and the subsequent marginalization of a systemic discourse, can be associated with three important developments during the period of December 1995 to March 1997 (Jansen & Christie, 1999). The first instance was the creation, by the Ministry and national Department of Education, of a number of stakeholder and expert commission teams, as well as counseling commissions, whose instruction was to improve the NQF and the idea of an cohesive method to school programs, using an outcomes-based practice. The National Department of Education issued, notably, *A curriculum framework for general and further education and training* (Republic of South Africa [RSA]. National Department of Education [NDoE], 1995), *Lifelong learning through a National Qualifications Framework* (Republic of South Africa [RSA]. Department of Education [DoE], 1996a; 1996b), and a *National Qualifications Framework* (National Curriculum Development Committee [NCDC], 1996), which were all definitive in establishing outcomes-based ET firmly in the South African educational plan.

The second decisive moment in establishing OBET as the dominant ET discourse was the release of the Department's first official public document on "outcomes-based education and training", issued in March 1997, entitled "*Curriculum 2005: Lifelong learning for the twenty-first century"* (Republic of South Africa [RSA]. National Department of Education [NDoE]. (1997a). Finally, the third development that contributed to the ascendancy of an outcomes-based approach was the launch, and first meeting of a fully constituted South African Qualifications Authority in August 1997, as well as the statutory deliberations, regarding the NQF, which followed thereafter (Brown, 2014). The South African Qualifications Authority has since passed a number of proclamations that begins to establish the essential building blocks of an OBET system, which is multi-dimensional. Its definition is elaborate, complex and bureaucratic. OBET is not about expressing learning objectives in the form of outcomes, because, this system shows the evidence of competence, in terms of standards recognized by the appropriate education, or training authority (Mulder, Weigel & Collins, 2007; Morcke, Dornan & Eika, 2013).

The following definition arises out of the Australian ET experience (Kraak, 1999; Cox, Imrie & Miller, 2014). Kraak (1999) indicates two central types of competency models: performance standards and criterion–referenced assessment. Standards are central to OBET models, as they specify the nature of the tasks to be performed. Standards are, therefore, performance objectives that must be achieved, but they also serve as criteria for assessment of competence (Brockmann, Clarke & Winch, 2008). Outcomes-based systems are founded on criterion-referenced assessment. This assessment method is distinct from the more traditional norm-referenced system. The comparison is between the abilities of an individual and those of some other population on which the test has been standardised. The aim of the assessment is usually to draw comparisons between individuals and to determine whether individuals are progressing satisfactorily (Snyder, 2010; Biggs, 2011).

The South Africa's OBET places an accent on the learners first. This learner-centred approach has involved a model shift in the learning method, far from the traditional syllabus-oriented, content-based transmission model of learning, to one based on outcomes. Considering learners as empty containers that have to be completed with information, and regarding learners as inactive recipients, or repetition learners, deprive many learners of suitable occasions to understand their full potential (RSA, NDoE, 1997a).

Curriculum design in OBET is to be clear and sharing, joining the efforts of all investors: parents, instructors, education authorities, specialists and the students. The curriculum framework is provisional, with piloting, experimentation and adaptation occurring throughout. Curriculum frameworks will vary from place to place, as the process becomes more flexible and responsive to diverse community needs (RSA, NDoE, 1997a).

The cumulative impact of all these elements is to create an environment for unified and successful learning, with few boundaries, barriers or exclusionary constraints hindering further learning. This unified learning is borne in Curriculum 2005 (RSA, NDoE, 1997a), when describing the benefits of an outcomes-based NQF model. These benefits include learning is achieved in formal or informal settings, learners are flexible between the education and working environments, areas of learning are connected allow learners to build on what they learn and easy transfer of recognitions and experiences from one learning situation to another.

The notion of ease of transfer from one learning context to another, implicit in unified learning, is perhaps the most attractive feature of the radical discourse of OBET, but it also represents its most problematic feature. The OBE method argues the content-based teaching method. OBE continues in assistance of allowing students and freeing serious expertise and abilities, to support learners in building their own meanings and knowledge, as well as assisting them to turn into experienced students. The OBE method is a learner-centred one, rather than teacher-centred. Students receive the main place, whereas instructors rehabilitated as administrators and screens in the knowledge practices of the students (Weimer, 2012; Garba, Byabazaire & Busthami, 2015).

OBE evaluations are founded mostly on recurrence knowledge and memory exercise. The development of a student is measured through the efficiency of the applied abilities. The Curriculum 2005 strategies assist students to make personnel decisions around their own enactment, recognised objective for improvement and advance education" (RSA, NDoE, 1997a)

As limitations of OBET,

- A substantial change in instructive viewpoint from large-scale concerns to a small-scale anxiety.
- A huge administration to describe, distinguish and display principles.
- The OBE insight appears as a system that was established in other nations, and incorrectly rearranged into South Africa.
- All stakeholders (instructors, officers, administrators and students were disordered, and did not appreciate what was expected of them.
- Other complicating factors around OBE and Curriculum 2005 included, too several design structures, lack of specifications, vocabulary that was challenging many learning regions.
- Lack of actual practices, incomes, assets and inadequate delivery of preparation for instructors.
- Knowledge emphases on proficiencies.

(Kraak, 1999; Gould, 2009; Scott, 2013).

The ET transformation method expressly addresses collective disparities among the present academic leaders and its professional substitute. This will remain largely unaltered by a reform project that simply tinkers with its assessment system (Bartlett & Burton, 2016).

3.2.3. Method Based Statistical Regression Model

The analysis of learning statistics cannot avoid the crucial question of comparability between Universities. Methods are constantly being developed and improved at institutional level, to provide measurements of learning statistics, particularly in universities with non-existent, or poor data qualities (Ben-Zvi, 2007). Until now, the methods developed to measure the ability, or knowledge, in statistics learning for most universities in the developed world, are generally based on statistical regression models. Comparison with national estimates, based on this method, sometimes resulted in different or contradictory results (Hampel, Ronchetti, Rousseeuw & Stahel, 2011). This section, however, displays the regression base model, generally used at university level, including UWC and UCT, to estimate statistics learning. The hypotheses, limits and advantages of the method are highlighted.

This model has the advantage of fair comparability between some universities treated on the basis of the same regression model. However, different methods were developed by the United Nation agencies to estimate statistics learning in the world. Depending on the source of data available at university level for the year of the estimate, regression methods are valuable mechanisms to examine the connection among multiple explanatory and outcome variables (Groves *et al.*, 2011).

The “ordinal regression” technique was applied to perfect the connection between the outcome variable, for example, diverse categories of the SELS beliefs, and the explanatory factors including individual characteristics and students’ learning environment at UCT and UWC. The SELS beliefs was measured on an ordered, categorical, and six-point Likert scale, “no confidence at all”, “a little confidence”, “a fair amount of confidence”, “much confidence”, “very much confidence” and “complete confidence”. It is unlikely to accept the regularity and consistency of the variances for ordered categorical outcomes. Therefore, the ordinal regression model develops a better demonstrating instrument that does not undertake the normality and constant variance, but requires the statement of parallel lines across all levels of the categorical outcome. It, therefore, is significant to distinguish in what way the model works, as well as the insufficiencies of the techniques (Elamir & Sadeq, 2010; Harrell, 2015).

For instance, if the logit link is applied, the ordinal regression model should be written in the following form:

> Let Y be a categorical response variable with k + 1 ordered categories where $\pi j\ (x) = \rho(y = f(X)$ is the probability for the realisation of Y= f, j=0,1, …, k and the cumulative probabilities $\gamma j(x) = \rho\ (Y \geq f(X)$. The class of grouped continuous model is obtained by the generalised linear model in which the cumulative probabilities are used instead of πf [γj (X)] = log { γj (X) / [1- γj (X)]}= log {[P(Y≤yj | X)/ P(Y>yj | X)}= aj + βX, j = 1, 2, …, k – 1, and γj (x) = $e^{(a\,j\,+\,\beta X)}$ / [1 + $e^{(a\,j\,+\,\beta\,X)}$]; where j indexes the cut-

off points for all categories (k) of the outcome variable. If multiple explanatory variables are applied to the ordinal regression model, BX is replaced by the linear combination of $\beta 1X1 + \beta 2X2 + \ldots + \beta pXp$ (Bender & Benner, 2000).

The function f [γj (X)] is named the link function that connects the systematic components (namely $\alpha j + \beta X$) of the linear model (Long, 2003). The alpha áj signifies a separate intercept, or threshold for each cumulative probability. The threshold (aj) and the regression coefficient (β) are unknown constraints to be assessed by means of the maximum likelihood method. The ordinal regression model with the logit link is also known as the proportional odds model, because the regression coefficient (for example, log odds) is independent of the category (Bender & Benner, 2000).

3.2.4. Other Methods

All existent methods are not covered in this section, but the most important ones, and the most used in developing countries, in general, have been mentioned. There are other methods to estimate learning statistics; however, these methods are not commonly used, for example, a structural equation modeling.

3.3. Causes of failure in SELS beliefs

Research on learning has revealed that limitations in human intuition, reasoning, thinking and sense of construction lead to the drawing of false conclusions that inhibit both individual and collective learning (Canon & Edmonson, 2005; Shipton, 2006). However, reference is made to the conditions and constraints affecting statistics education in developing countries. As was explained in chapter 1, the importance of networking is useful to expand policy formulation and learn from experiences in learning statistics education reform. How the interaction is organised is reported in detail in chapter 4. There are many aspects of failure in statistics learning, which are grouped into four categories, namely, statistics anxiety, attitudes towards statistics, ability to learn and social support.

3.3.1. Failure in SELS Beliefs due to Statistics Anxiety

In order to appreciate the degree of failure in SELS beliefs, this section examines the causes that emerged from statistics anxiety. Anxiety arises from the learning process of the statistics content. This implies that anxiety relates to self-focused, adverse and nervous reasoning throughout the learning process. Extremely worried students often have comparatively adverse self-concepts, undervaluing their ability (Wigfield, Eccles, Roeser & Schiefele, 2008). Geary *et al.* (2008) examined a task group's work on learning processes, as well as how to learn concepts and skills among children. These authors found that general anxiety could reflect a tendency for students to over-generalize mathematics related competence. Scholar beliefs around the reasons of their achievement and disappointment have been recurrently related to their appealing and persevering in knowledge actions. Self-efficacy has performed as an important associate of educational results. However, the reason and consequence among self-efficacy and mathematics education remains to be completely strong-minded, as does the comparative prominence of self-efficacy against aptitude in moderating these conclusions. In addition, Geary *et al.* (2008) observed that anxiety is connected too little mathematics marks, incompetence to join progressive mathematics classes, and deprived marks on consistent exams of mathematics attainment.

Anxiety is an important affective variable that must not be ignored. It needs investigation as it may interfere negatively with the learning process at different levels; therefore, affecting the learners' performance and achievements (Onwuegbuzie & Wilson, 2003). These authors describe statistics nervousness ascends once a student encounters statistics in any practise and at any level". Statistics caused undesirable emotions, hinders achievement on tasks. They more declare that their discoveries support statistics anxiety as a major prognosticator of achievement in statistics and research methodology courses. In addition, Pan and Tang (2004) reveal that applying statistics to real life conditions is helpful in decreasing the level of anxiety in statistics courses. Many students hurt from anxiety and pressure, and ascribe to their accomplishments to outer factors, for example, chance (Kuh *et al.,* 2011). Hembree (1988) argues that in academic achievement, lesser stages of self-efficacy are connected to greater anxiety, and to larger gaps in task understanding. Therefore, a personal's self-assurance in his/her aptitude is a valuable requirement for success in a statistics course (Gal, Garfield & Gal, 1997).

An extra difficulty to active statistical knowledge is subsequent in misconceptions and mistakes, which reduce students' self-assurance that they will always appreciate the subject (Huck, 2015). Several outcomes indicate ideas such as, the disappointment of an average (a sample mean) to describe a distribution truthfully. Such failure could lead to confusion and despair (Martin, 2003). Concerning interest in the material, Hirsch and O'Donnell (2001) settled a valid and reliable test instrument about probability and logical evidence about students' errors, to detect fallacies around research representativeness. Zieffler and Garfield (2009), as well as Garfield and Ahlgren (1988) assert that students with approved training in statistics, carry on to experience misunderstandings, due to the influence of their feelings towards statistics. Derry, Levin, Osana and Jones (1998) assert that students' scientific and statistical reasoning skills are lacking; however, it could be improved through instruction. Therefore, according to the researcher, it seems that most students enrol in postgraduate programmes with exact slight prescribed knowledge of the rules of likelihood and probabilistic cognitive, for example.

Therefore, statistics anxiety is an important predictor of SELS beliefs, and based on the above-mentioned reviewed information, the researcher would be interested to know what the statistics anxiety level of graduate students could be at UWC and UCT. The autonomy of making decisions and the ability of SELS beliefs are the important differences between the anxious and non-anxious postgraduate students, regarding their exposure to statistics anxiety. Ultimately, the impact of statistics anxiety on SELS beliefs, across universities, also needs to be explored.

3.3.2. Failure in SELS Beliefs due to Attitudes towards Statistics

Attitudes towards statistics factors are usually considered as direct predictors of SELS beliefs (Hsu *et al.*, 2009), which implies that their influence on SELS beliefs immediately reduces or increases the level of SELS beliefs. Ary, Jacobs, Sorensen and Razavieh (2010), as well as Bean (2011) conclude that writing a task is an effective way to influence students towards a positive attitude of statistics. Relating statistical perceptions to explain existent world problems provides students with occasions to strengthen what they have learned, which reports problems that many of them regard as problematic. Such students develop a negative attitude in their situation. In addition, high levels of worry act as an external cause of failure. Therefore, they are more suitable to use repetition learning activities, at the expense of more exciting work, which requires high organization thinking skills. Students, on occasion, need extra time to respond to queries, or to investigate imperfect responses for clearness.

In their study, Pan and Tang (2005) reveal that the availability of assistance is an important motivation for students, whenever they are experiencing difficulties with their learning activities. Frustrations can be reduced, if the availability of assistance is regularly planned and achieved. In addition, Pan and Tang (2005) suggest that the instructor's attitude, as well as their manner of evaluating learning statistics outcomes, need to be improved to include different assignments in the grading of the course. Multiple assignments provide students with occasions to strengthen the well-read ideas, in addition to the tutoring in the class, while the homework should be practical activities of real world problem solving.

Kahneman, Slovic and Tversky (1982) claim that mistakes in reasoning about concepts in statistics persist, when students attempt to make decisions that involve chance and uncertainty. These errors are grouped in two categories: errors of application and errors of comprehension. Errors of application also constitute the causes of failure, as students often know a rule very well, but are unable to apply it. Kahneman *et al.* (1982) observed that some biases and errors in decision, under doubt, necessitate a double examination, which clarifies the selection of a particular wrong response, in terms of heuristics, and also elucidates why the accurate rule was not well-read. In fact, these errors tend to be reliant on on the students' individual understandings. Nisbett, Fong, Lehman and Cheng (1987), in their study with university students, argue that exercise them in different features of the guidelines, by means of examples, improves the quality of their statistical reasoning. The improvement of students' statistical reasoning may be achieved by using formal or informal approaches of evaluation, to enable them to distinguish between precise or incorrect cognitive.

According to the researcher, discrepancies have been well-known, regarding the manner in which the students reason across items. It may be more valuable to have some diverse appraisals, each estimating reasoning about a particular statistical concept (Garfield & Ben-Zvi, 2007; Garfield & Zieffler, 2012). Particular emphasis should be given to the use of qualitative methods, which may offer ways to develop quantitative instruments, based on questions used in the qualitative studies.

The extent, to which students perform in their academic work, may fluctuate in the degree, to which they emphasise on certain indications, as well as how they conceive, understand them and how they understand their material (Laurillard, 2013). However, individual differences result from environmental influences, prior experiences or differential treatment by facilitators/ supervisors (Maouche, 2010). Financial constraints affect student outcomes in statistics courses. Students, who are financially insecure, find it difficult to put more effort into their studies, than those that are financially secure (Zimmerman, 2003).

The organization of learning is a difficult task for many students. Although there are many approaches to learning, many students often find it difficult to select the correct approach (Entwistle & Ramsden, 2015). Over the past decade, many researchers have revealed weaknesses in organizational learning, because of failure on multiple levels of analysis (Canon & Edmondson, 2005). The failure of students to address warnings tends to aggravate this failure in statistics learning, which reveals the problem of discipline in the formal supervision (Knight, 2012). Students, who experienced all these features, are supposed to adapt some strategies during their learning process, such as learning from failures, which is an imperative monitor of preparedness for tasks (Knight, 2012; Ryan, 2013).

As mentioned above, there are many approaches to learning: students working in formal groups, in classrooms for assignments. Also, students working alone, or in small groups, typically research a topic and present their work to their peers (Jacobs, McCafferty & Iddings, 2006). Several overviews of alternative or new assessments refer to a complex organizational system (Magin & Helmore, 2001; Topping, 2009). Another approach includes workshops, oral presentations and conferences (Topping, 2009). This makes it easier to diagnose and correct the causes of failures in SELS beliefs.

Failure in self-efficacy is attributed to unsuccessful performance. It reveals an absence of aptitude; lack of achievement due to behavioural factors, such as effort; lack of prior information; and lack of attention in the material (Heiman, 2006; Hsieh & Schallert, 2008; Alderman, 2013). As mentioned earlier, some changes observed depend on the greatness of the apparent risk to an individual's knowledge of capability that is inferred by disappointment under aptitude or effort ascriptions (Bandura, 1997). Onwuegbuzie (1997) argues that failure is due to the confusion about statistics, and the undesirable practices in past statistics classes. Generally, students, who are unaware of their difficulties, experience more problems than those, who are aware. This experience and their way of thinking make them fearful of statistical concepts, as they do not have sufficient mathematics and statistics training. The fright of failing the course grounds students to delay enrolment for various statistics courses, which often leads to the failure in degree programmes completion.

However, the failure of students to adapt to any of these approaches and their lack of understanding of the essential processes, results in failure from learning statistics. Therefore, in this current study, it was advisable to determine, firstly, what the graduate student's attitude was towards a statistics level for each institution, namely, UWC and UCT. Secondly, to determine what the impact of attitudes towards statistics on SELS beliefs was at UWC and UCT, and thirdly, to determine whether these factors were identical across universities

3.3.3. Failure in SELS Beliefs due to Individual Characteristics

The concept of individual characteristics, groups many variables, including age, ethnic group, gender, marital status, postgraduate programmes, student status, department, type of study and academic institution (Artino & Stephens, 2009). The problem of learning statistics could be approached from a socio-cultural perspective. In this case, it is suggested that social and cultural values establish the societal norms. These norms would guide the daily life of the community members, as well as dictate what is tolerated, or banned, within the population group (O'Reilly, Ryan & Hickey, 2010; Yusoff, 2012). In a given society, socio-cultural values form the foundation of the judgment of behaviours and practices. The magnitude of customs, practices and tolerated facts, related to failure in the ability to study mathematics, or mathematics related subjects, could explain the level of SELS beliefs, in a particular ethnic group (Kane, 2016).

At individual level, the degree of acceptance of, or resistance to, socio-cultural pre-established models of behaving, as well as ways of thinking, would define the influence of socio-cultural norms on members (Goodwin, 2013). Belonging to different socio-cultural groups, would also create disparity among students, regarding their behaviour and disposition to failure, in learning statistics (Scott, 2007; Walter & Andersen, 2013).

Socio-cultural values are in a constant and permanent state of mutation, due to the mixture or clashes with other cultures. The exposure to different cultures, sometimes with opposite appreciations about social behaviours, could create a change, regarding the respect, or practice in the community or ethnic group. The socio-cultural factors of learning statistics are all considered distant predictors of learning statistics (Barnes, 2013; Viberg & Grönlund, 2013).

The traditional socio-cultural aspects of failure in learning statistics reflect the moral obligations, with respect to the tradition and customs. The traditional socio-cultural response to failure in learning statistics issues is based on the exposure, practices and rigorousness of norms and customs related to applied mathematics performance in a community or ethnic group. Ethnicity is included in the traditional socio-cultural factors of learning statistics (Howard, 2010; McCarthy, 2014). However, it is worth highlighting that the ethnic group is the root of the students' perceptions, behaviours and practices, related to studying mathematics. In rural areas, where tradition is still strongly respected, the ethnic group could determine the opinion of a student about a particular field of study, as well as the choice of courses (Arum & Roksa, 2011; Bain, 2011). Most African customs present important similarities about education behaviours. However, some ethnic groups are more flexible, while others are very strict, concerning respect for the pre-established norms, specifically regarding education and mathematics (McCarthy, 2014; Grech, 2014). Therefore, the risk of failure in learning statistics could depend on whether an individual is a member of a rigid ethnic group, or a flexible ethnic group, with respect to norms, cultures and traditions (Gay, 2010; Hollins, 2015).

Concerning education, practices and customs differ among ethnic groups, which could influence the level of SELS beliefs and exposure to failure in learning statistics. In some ethnic groups, entering the mathematics, or statistics fields, is very difficult because of the requirements, while others' customs make access more affordable and easier. As a result, some ethnic groups register more mathematics and sciences students, than do other groups. Therefore, the exposure to high SELS beliefs and failure in learning statistics could depend on the ethnic group (DeVaney, 2010; Hannigan, Hegarty & McGrath, 2014).

The position of all ethnic groups on statistics and failure in learning statistics matters is almost similar. The impact of ethnicity is more dependent on the level of respect the members have for the norms and values, and the reaction of the ethnic group regarding any violation of established "norms" (Hollins, 2015). Concerning statistics or mathematics in general, for example, the African/Black ethnic Groups, as well as the Indian/Asian groups are usually cited in the literature as being very strict. However, the ethnic White and Coloured groups are presented as less conservative (Visser, 2005). Existent researches reveal that people from the African/Black and Coloured ethnic groups are less likely to be educated, compared to ethnic White and Indian/Asian groups (Visser, 2005).

The department, type of study and academic institution are factors of exposure to new environments, modernisation, as well as cultural mutation. Under the influence of the environment, students in urban areas can change their practices and behaviours, disregarding the norms of their ethnic group. Students from the same ethnic group can behave differently, according to their area of residence (urban/rural). Undergraduate and postgraduate students do not have the same disposition toward others people' cultures, values and norms and, therefore, do not behave in the same way, regarding some practices. The respect of customs and traditional practices are less probable among postgraduate, than among undergraduate students. Similarly, the autonomy of making decisions and the ability of SELS beliefs are significantly different, depending on their exposure to the academic institution (Wang, 2012; Wang & Eccles, 2013).

Among the demographic risk factors of SELS beliefs, the student's gender is generally cited in literature. Some authors, for example, Teman (2013), classify gender as a biological factor of SELS beliefs. However, Rodarte-Luna and Sherry (2008), as well as Beurze *et al.* (2013), consider gender a female characteristic. Whatever the classification made, Rodarte-Luna and Sherry (2008), Beurze *et al.* (2013), as well as Teman (2013), reveal that gender is an important determinant of SELS beliefs. Their findings reveal that the diminution observed in SELS beliefs levels, is due to the higher levels of the lack of computational skills achieved by females (Rodarte-Luna & Sherry, 2008; Beurze *et al.*, 2013). For Rodarte-Luna and Sherry (2008), the risk of SELS beliefs is, at least, double for women.

The researcher noted that the students' marital status was not considered a statistical risk factor of SELS beliefs in previous research. Even if their explanation was based on the availability and accessibility to good knowledge in statistics learning, the situation is more complicated in the case of Africa (McMillan & Rodrik, 2011). Generally, in Africa, married students are under family and social pressure, regarding their marriage obligations. Due to the strength of cultural values and poverty in most of developing countries, marriage remains a constraint to the development of the married students, because of the obligations of the couple and the family financial constraint (Jayachandran, 2015). Therefore, unmarried students could be more exposed to high levels of SELS beliefs, as young students are available for practical tasks, and more flexible to cope with statistics programmes. In addition, married students are under more pressure to find employment, and, consequently, have limited consultations with statistics monitors and supervisors, leaving them more exposed to complications with their studies (Ismail & Abiddin, 2009; Rubin & Babbie, 2016).

In this current research, the amount of background information available, therefore, is a critical factor in determining the confidence and/or trust of the students in statistics learning, as there is a need for a clear understanding of how the background information affect the SELS beliefs across universities (Biggs, 2011).

3.3.4. Failure in SELS Beliefs due to Social Support Factors

Living in a fresh setting generates many life variations, such as adapting to new habits of acting, learning an innovative customs, developing networks and being exposed to a system of educational policy, which is unfamiliar to known policies (Bandura, 1994; Bentley, 2012). Various situations are encountered, such as learning new social customs and behaviours, go through a diverse climate and foods, as well as correcting to the language spoken, if English (the language of instruction) is not the student's first language. Therefore, international students practice problems regulating to a innovative approach of life, beside with the rigorous educational burdens, which could place an universal student at bigger danger, than the indigenous students. Problems faced by worldwide students could include financial pressure, solitude, and accommodation problems (Abdullah, Adebayo & Talib, 2015).

Cohen and Wills (1985) examined the effect of social support on well-being. They observed that social support is related to the well-being of individuals under stress. Cohen and Wills (1985) categorise four support resources, namely, *esteem support*, indicating that the individual is valued and accepted; *informational support*; *social friendship*, for example, pleasing easy with others; and *material support,* the provision of financial aid, material resources, needs-based services. This variable is significant, in terms of the likely cushioning effect it may have on the other independent variables, namely, statistics anxiety and attitude towards statistics. Similarly, Perepiczka *et al.* (2011) reveal in their study that social support acts as a buffer to dysfunctional opinions or attitudes.

Having examined the various causes of failure observed in SELS beliefs, in more detail, the researcher is of the opinion that the correlations between SELS beliefs, individual characteristics, experiences, statistics anxiety, attitudes towards statistics and social support factors should be explored at this stage.

3.4. Correlations between SELS beliefs and various predictors

Bandura (1986) defines ability as people's conclusions of their competences to organise and perform tasks, or developments of action, compulsory to achieve chosen categories of performances. Prior performances, or prior knowledge, advice and information received from people, namely, parents, teachers and peers, as well as the level of emotional anxiety, contribute to the judgments about an individual's ability (Reeve, 2014). Students use Knowledge from many foundations to form their self-assurance beliefs, and, consequently, apply these perceptions about themselves, by comparing their knowledge to others (Usher & Pajares, 2008; Brophy, 2013). In this manner, Bandura (1993) argues that students, who have a little confidence in statistics, for instance, may withdraw from difficult tasks. Generally, because of their lower aspirations and weaker commitment to learning issues, students do not concentrate on how to perform well, as they spend most of their time, focusing on their limitations and failures (Entwistle & Ramsden, 2015). Bandura (1997) improves his definition by emphasizing new aspects of perceived self-efficacy as, a personal's decision of aptitude to perform a specific activity. This judgment covers four points, namely, prior experiences, experiences from observations of others, verbal persuasion and social influences that an individual possesses certain capabilities, beliefs and feelings. Students, who construct their ability as ineffective, tend to abandon simply and settle on their misperceptions; thereby, mocking their engagement from the task at hand (Linnenbrink & Pintrich, 2003). Therefore, the inability of students to achieve their work is related to their low academic expectations.

Statistics learning is a worldwide human endeavour, which has been the topic of extensive research over the years (Garfield & Ahlgren, 1988; Gal & Ginsburg, 1994; Gardner & Hudson, 1999; Mvududu, 2003; Latief, 2005; Makapela, 2009; Perepiczka *et al.,* 2011). Garfield and Ahlgren (1988) investigated how undergraduate students tend to solve statistics problems, without forming an internal representation of the problem. Students memorise the steps and formulae to follow, including well-defined problems, but are unable to discern what the rationale is, or how the perceptions could be applied in innovative circumstances (Garfield & Ahlgren, 1988). Considering the progress made on new statistics teaching and learning; learning tasks and prior academic background are factors of achievement (Gal & Ginsburg, 1994).

In addition, society is dynamic and social institutions change over time; however, these changes may compromise the interests of some institutions, while favouring others (Davidson, 2010). According to this perspective, Gardner and Hudson (1999), at two universities in Australia, examined the ability of undergraduate and post-graduate students to apply statistical procedures, as well as reasoning processes, in order to identify difficulties faced in graphing tasks. The students' outcomes depend widely on their levels of statistical knowledge; for example, a master's course-work student, who had worked as a research associate in psychology, could fully answer eight out of the 34 items correctly, while an undergraduate student could succeed in only six items. The sample size and the diverse background of the students, made it difficult to generalise, accurately, to a wider population. The clarity of the data reveals that there is a serious discrepancy between the students' self-reports of their familiarity with the concepts, and their real ability to use them correctly.

Based on the social environment and the possible change observed over years, Mvududu (2003) examines the connection among a constructivist learning environment (CLE) and students' attitudes toward statistics, as well as whether the liaison depends on the setting. The undergraduate participants were selected from Seattle Pacific University in the USA and the University of Zimbabwe. The author used a "principal component factor analysis" (PCA), with varimax rotation. The Zimbabwean students presented a comparatively larger predilection for a CLE, compared to the American students. The effect was most noticeable on the student concession variable. The modification in preference for common control could result from a cultural change. However, the foregoing information suggests that the students' attitudes towards statistics are good manifestations of a CLE.

Therefore, Latief (2005) explores the throughput rate of UWC students, who had completed at least one semester of third-year level statistics (Mathematical Statistics or Applied Statistics) in the Department of Statistics at the UWC. The data were retrieved internally from the University's records. The study design was a historical cohort (retrospective). A logistic regression model for each independent variable was constructed. Each model was appraised by the ratio observations, suitably predicted by the model as only 21% of the observation. All models were evaluated at a likelihood threshold of 0.22 for comparison purposes. The full logistic regression model properly predicted 68.3% of the observations at a likelihood level of 0.22. For a probability level of 0.04, the model suitably predicted only 21.4% of the observations. The model with only the Year covariate and the Collective was the finest model to expect throughput. It properly predicted 76.1% of the observations. A logistic regression model for each predictor variable and a full logistic regression model were built.

The decision-tree examination reveals that the Grade 12 collective and the political setting were the greatest noteworthy observations to separate between students finishing their studies in the prescribed time, and students taking more than three years. The model could promote with university strategies, concerning student assortment.

Similarly, Makapela (2009) evaluates an introductory statistics (IS) course at the UWC. The study designed a programme to monitor an introductory statistics course for a period of five semesters, in order to identify patterns of students' performances in the course, as well as students' perceptions and satisfaction with the course content, resources, lecturers and support systems. The participants in the study were recruited based on their Grade 12 background, demographic information and parents' background. The retrospective study was based on the causes of success, or failure, of the introductory statistics (IS) course. The study identifies the lack of facilities as the major challenge. In addition, it reveals that the students' understanding of the probability section of the statistical test is worsening, especially among students with a conditional exemption. It is clear from the Makapela's (2009) conclusion that a review of the entry symbols, for a possible increase of the level of requirement, will secure the future of under-prepared students, with below-standard entry requirements.

Perepiczka *et al.* (2011) investigate the association between self-efficacy to learn statistics (SELS) and statistics anxiety (STARS), attitude towards statistics (SATS), and social support (MSPSS) of graduate students, enrolled in programmes at colleges of education. In addition, their study explores the procedural knowledge of graduate students in statistics courses, as well as the implications for educators. In order to realise suitable control in the study, 119 participants were recruited through an online survey in 27 states of America. A "multiple regression" analysis was conducted to regulate the connection among SELS, STARS, SATS and MSPSS. The analysis revealed a meaningful association between SELS and STARS, SATS, and MSPSS. STARS and SATS are statistically important predictors of self-efficacy to learn statistics, while social support was removed in the model.

Under the influence of the environment, students in developing countries could change their practices and behaviours, disregarding the norms of their SELS beliefs. Students from the same programme could behave differently, depending on their academic institution. However, researchers reveal that SELS beliefs are decreased with high level of statistics anxiety and negative attitudes towards statistics, across the world, with still huge disparities at university level. This dimension has raised questions about the relationship mechanisms between SELS beliefs and the above predictors, which remain unchanged at universities in South Africa.

3.5. Recommendations for the implementation of policies

Monitoring and assessing change in learning achievement depends on different approaches. New learning through UNESCO, the World Education Forum in Dakar, and the White Paper Three recommendations are addressed, in order to improve the application of statistical procedures in academic research, in the HES (NCHE, 1996). However, the research volume and performance of the system, includes post-graduate exercise, research organization, and ways of developing research strength in higher education (Johnstone, Arora & Experton, 1998; Lawton Smith, 2003).

3.5.1. UNESCO Policies

Many scholars encourage a re-evaluation of the role played by international organisations, such as the United Nations (UN), Bretton Woods institutions, and the "United Nations' Educational, Scientific and Cultural Organization" (UNESCO). They argue that international organisations are necessary, at present, to redirect processes toward education purposes (Jones, 2006; World Bank, 2011). UNESCO (2005) has encouraged countries to adapt to change, in the context of multilateral cooperation in education. This is to be achieved through learning from indigenous and traditional patterns.

UNESCO provides recommendations to determine the learning quality in higher education, as it involves the application of statistical procedures. However, learning statistics must be relevant, responsive and accountable in the higher education (Dwyer, Millett & Payne, 2006; Scott, Coates & Anderson, 2008; Falchikov, 2013). Despite the fact that learning in order to become strong advocates for the new approaches to higher education learning, the goals of different assessments must be tied to improving learning that motivates institutions to uncover weaknesses, and advances the learning process (Falchikov, 2013). Learning statistics is responsive, if the attempt reflects a suitable mechanism for learning (Pierson, 2008). Effective, responsive learning includes the diagnosis, motivation, feedback and improvement of learning. Students are aware that they are being evaluated. Research provides strictness and integrity to identify sharing knowledge and effective learning methods (Rubin & Babbie, 2016).

According to Casas (2010), learning is accountable, when the assessment tool provides students with occasions to report their learning practices, which reflect on improvement, difficulties and connection in concepts. Similarly, Gregory and Herndon (2010) assert that students are required to mention the different approaches they apply, and express their feelings about learning. Additionally, Zimmerman (2008) suggests that students are required to have a learning journal for a personal record of their experiences, which could be used to provide a self-report of their learning. This learning journal captures information concerning how problems were solved, what failure in their reasoning occurred and what approaches were observed to be helpful.

Silverman (2013) stresses that students need to be clear, explicit and precise about what to record, how much detail to record, and the type of analysis to conduct, prior to submission. However, problems of unwilling respondents and poor recruitment are helpful as the formal requirement to keep a journal as part of the draft. Incidentally, supervisors encourage a written record from students, because they correct an essay, using guidelines that provide the criteria, against which to judge the work. Similarly, learning, using portfolios, is authentic, as well as appropriate to demonstrate valid claims, and of sufficient record for the advisor to infer that learning is still current (Falchikov, 2013). A portfolio remains the practical and intellectual property of the student who develops it. Given the personal nature of journals, peer assessment is not a suitable method.

The growing attention in the procedures of worldwide authority, provide an initial argument, which emphases on the exertion of UNESCO. It affords an analytical re-evaluation of UNESCO's effort in learning, over the last five decades, informing this story to comprise the greatest recent decade of crisis and improvement within the organization, and within the United Nations, more approximately. Students initiate to share their diverse experiences, as well as combined facts, to enhance the idea of learning statistics (Trowler, 2010).

Since 2000, many initiatives have endeavoured to achieve the EFA goals; more than they did in the decade following the "World Conference on Education for All", held in Jomtien, Thailand (WCEFA, 1990). In fact, the Dakar Framework for Action (World Education Forum, 2000) provides a much stronger platform for action, than was the case in 1990, into the first decade of the 21st century. Recently, a loose coalition of structures, mechanisms and initiatives, which are not part of any central international arrangement, with international partners, has developed (Fullan, 1993; Chabbott, 2013). Therefore, it would appear that the Jomtien vision on education for all was not implemented by all nations. This lack of implementation yielded the outcomes of the Dakar Framework for Action (World Education Forum, 2000), where a single agency, UNESCO, was given the mandate to coordinate and inform international work, learning from the lessons of the International Consultative Forum, and from other international coalitions (Packer, 2008).

At present, the educational system has become a pivotal point and has to be considered a focal human right, or a way to set the mind free from the process of dependence. Therefore, as is the case with most knowledge, it should be considered a tool for both the modernisation and the democratisation of societies (Alexander, 2008). However, not everyone agrees with this, and while some people are against education in some cases, not everyone is completely committed (Bhola, 1990).

UNESCO, through their academic programme, improves important abilities in learning statistics, counting problem-solving abilities, applications of different procedures and the ability to work together with specialists, supervisors, and facilitators. These main aptitudes are developed in learning situations. UNESCO encourages students to continuously search for new patterns and revolutions, as all the answers for creating maintainable futures, are not available (Mogensen & Schnack, 2010). Competencies are acquired in real-world learning occasions, which seem conductive to familiarise students to concerted research between academic researchers and experts. Linking knowledge to action creates general difficulties of application and organisational learning, which draw consideration to dangerous success characteristics, such as collaboration, direction and combination for students (Lang *et al.*, 2012). In addition, linking knowledge to action presents the opportunity to organise the evidence on what can be done to promote learning equity, and to foster a global collaboration of policymakers, as well as researchers, led by supervisors or facilitators with academic and advocacy experience.

During the 4th International Conference on Environmental Education, some resolutions were taken jointly by UNESCO and UNEP to promote learning that engages practices, and strengthens dialogue, as well as advocacy skills (Smyth, 1987). If graduate students are to handle ingeniously and effectively with the world challenges, to which they are exposed, higher education needs to find innovative ways to develop students' capabilities to respond to such challenges. Therefore, UNESCO endorses learning for the achievement of equitability and quality for all students, and reassures the practice of checking, as well as assessment practices that are intended to be an appreciated knowledge technique for all students involved (Biggs, 2011; Looney, 2011). Literature on sustainable education requires instructional revolutions that deliver cooperating, practical, renovation and real-world knowledge (Sipos, Battisti & Grimm, 2008).

The "Bonn declaration" (UNESCO, 2009) invites educational leaders to build the ability to turn information into achievement for learning expansion. Based on this restructuration, students have to change the way they understand learning issues, and educators have to change the way they view knowledge, as well as communication practices. In addition, simply changing the sites of learning, as well as their participation patterns and practices, tend to enable students positively, to improve their skills. An growing amount of institutions are committed to instruct, not just a few experts, but a new cohort of researchers and specialists, who contribute in knowledge conversions (Crow, 2009; Arima, 2009). The researcher imagines that it is problematic to make the necessary determination to achieve these objectives, and, even in the nonappearance of this reason, to persist owing to a logic of cohesion with individuals and the setting.

3.5.2. The World Education Forum in Dakar, April 26-28, 2000

All nations have a duty to emphasise quality education for all a truth, in agreement to the promises made at Dakar (Alexander, 2008). Regarding higher education, the Dakar objectives obviously highlighted the eminence characteristics of learning (Thomas, 2009). These objectives include:

- learning requests of all people, being achieved over and done with impartial admission to suitable learning platforms;
- attaining a 50% advancement in the stages of adult literacy by 2015, expressly for women;
- fair admission to simple and on-going learning for all adults;
- refining all features of the quality of education; and
- confirming fineness by all in literacy, numeracy and essential life skills.

(World Education Forum, 2000).

However, the commitment to improve all the aspects of quality education is required, to ensure the effectiveness and efficiency for all.

Methods of assessing student learning through conventional approaches, such as essays, multiple choice questions and approaches based on self- and peer-assessment, are highlighted in this study (Gibbs & Simpson, 2004; Brown, Bull & Pendlebury, 2013). However, three themes emerge from these methods: effectiveness, efficiency and ability. The strategy is to provide experiences and assessments for students that empower them to become independent, self-motivated students, who have an abundance of problem-solving strategies for working with materials, concepts and people (Brown *et al.*, 2013). The assessment of students' understanding of these themes (effectiveness, efficiency, and ability) is important (Pearshouse *et al.*, 2009; Brown *et al.*, 2013). This provides students with strategies to think about other deep issues that they encounter in their working lives.

However, only a few scholars focus on the assessment of student growth efforts (Biggs, 1999; Heck & Hallinger, 2009; Black & Wiliam, 2009). An assessment is defined as a goodness of match between objectives and student achievement (Suskie, 2010; Falchikov, 2013). Two approaches, namely, formative and summative assessments need to be clarified. In summative assessment, students are accredited at the end of a programme; while in formative assessments, the intention is to identify scope and potential for improvement (Yorke, 2003; Scott & Fortune, 2009; Price, Carroll, O'Donovan & Rust, 2011). Therefore, the results of formative assessments are used for feedback to supervisors and students alike (Juwah *et al.*, 2004; Hounsell, 2007; Falchikov, 2013). Formative assessment is considered the heart of effective learning, with self-assessment as an essential component of formative assessment (Black & William, 1998; 2010). Many studies reveal that formative evaluation enable low achievers more than other students (Nicol & Macfarlane- Dick, 2006). Formative assessment is evaluated at the end of the curriculum, to provide successful action and to ignore problems of creating shared implications (Black & William, 2006; Falchikov, 2013). At the summative limit, shared meanings are important, and undesirable consequences that emerge, are often judged by appeal to the need of creating consistency of interpretation (Wiliam & Black, 1996; Knight & Yorke, 2003; Knight, 2012). However, this current study relies more on formative assessment.

In addition, the eminence feature of learning is one of the best debated points from Dakar. It is problematic to detect variables to describe and assess quality learning, as well as to designate a joint meaning (Onwe, 2013; Jerrard, 2016). The approach learning makes the students for lifetime, is harder to describe, and varies from university to university, as well as country to country (Biggs, 2011). For instance, contrary to South Africa, there is little informed debate on reforms in higher education in India (Agarwal, 2006). Additionally, the public strategies on higher education are not founded on long-term concerns. These guidelines do not cautiously consider the adjustment between inconsistent goals, and disregard the fact that the markets are now the main arbitrators of resource distribution. There are no in-depth studies of the diverse approaches and significances on the registration and achievement degrees, or the students knowledge in the long-standing (Jaggars, Hodara, Cho & Xu, 2015). However, the policy has to take into consideration the forces of globalisation, the main socio-economic factors, and its traditional factors of production (Moloi, Gravett & Petersen, 2009).

Different recommendations, regarding social cultural factors and statistics anxiety, indicate that negative attitudes towards statistics usually revolve around improving strategies during learning statistics, the application of several different assessments of statistical concepts, and learning from failures (Durlak, Weissberg, Dymnicki, Taylor & Schellinger, 2011). There is no doubt about the strength of these recommendations. It is certain that many students, who are learning statistics, could be assisted, if they received the appropriate support, in time, from trained professional statistics monitors, or supervisors, in situational learning related complications (Allen, 2016). The evidence about the capability of these recommendations to support students against failure in the application of learning statistics procedures (Means, Toyama, Murphy, Bakia & Jones, 2009). The prediction approach aims to avoid difficulties related to learning statistics through measures based on diverse factors, such as social, cultural, statistics anxiety, attitudes towards statistics, to name a few (Keller, 2009; Frankfort-Nachmias & Leon-Guerrero, 2017). For many researchers, the improvement of these factors should be the main strategy reduction of failure in SELS beliefs (Schunk & Zimmerman, 2003).

According to the Dakar framework, emerging and redressing learning and learning schemes, need the considerate, obligation and dynamic contribution of those in a straight line involved, and of the people at huge, namely, instructors, parents, students, the educational public, NGOs, private enterprise and the house of worship (Luong & Nieke, 2014; Makaaru, Cunningham, Kisaame, Nansozi & Bogere, 2015). The Dakar framework essentially means updating, or reorienting these plans, as excellence, effectiveness, fairness and gender impartiality in learning, are nationwide and worldwide objectives (Brenes, 2008; DaSilva, 2011).

3.5.3. The Recommendations of Education - White Paper 3

The post-apartheid higher education sector suffered from fragmentation, and the inability to come across the experiments of reorganization and expansion (Woodrooffe, 2011; Bozalek & Boughey, 2012). While the Bantu Education Act was designed to move all stages of education, it did not influence admission process to higher education (Motala, 2011; Woodrooffe, 2011). The South African government published the Education White Paper 3, entitled, "A programme for the transformation of higher education", with a set of goals (RSA, NDoE, 1997b; Fiske & Ladd, 2004). The main objective was to restructure education system into a national synchronised system. Unfortunately, the White Paper 3 could not appropriately emphasise equity policy in the distribution of facilities, capacities, staff members and the participation rates of students (Woodrooffe, 2011). Three years later, the Council of Higher Education issued a new policy paper, entitled "Towards a new higher education landscape", advocating the achievement of equity, quality and social development imperatives of South Africa in the 21st century (Republic of South Africa. Ministry of Education [MoE], 2001).

Regarding all other learning areas, Social Sciences revolved around the fulfilment of certain acute endings. Many of these were helpful to statistics learning (Badat, 2010). A self-regulated student should have the following competencies in problem solving, critical thinking and communicating effectively, using mathematics and technology (rational abilities/problem solving; groupwork/people skills; independence and self-management skills; investigation abilities; communication aptitudes; Technological and environmental health and reasoning skills) (Barak, 2010; Kim & Hannafin, 2011; English & Kitsantas, 2013).

The White Paper 3 emphasises the revolution of higher education through the growth of principles with new planning leading the higher education in South Africa (RSA, NDoE, 1997b; Jansen, 2002). The study focuses on the following principles, as recommended by Education White Paper 3: impartiality and reparation, expansion, excellence, efficiency and effectiveness. These principles are related to learning statistics and academic research, as well.

The principle of equity implies a precarious recognition of prevailing differences, which are the outcomes of rules, structures and practices, based on ethnic groups, gender, marital status, and other forms of discrimination (Beckmann, 2008; Badat & Sayed, 2014). For instance, statistical education is essential at all levels of education, as it equips the individual to acquire knowledge for appropriate reasoning, in the context of solving real world problems (Perkins, 1985; Şendağ & Odabaşı, 2009). Such change takes account of, not only eradicating all undeserved discrepancy, but also the actions of empowerment, equal opportunity for everyone. The empowerment of students in statistics learning often is unsuccessful to see the relevance of likelihood. The most formal instructions fail to clarify what inspirations exist between the real data-based world and the model world (Palmer, Zajonc & Scribner, 2010; Keim, Kohlhammer, Ellis & Mansmann, 2010). Despite multiple efforts, the South African government struggles to promote equity in education. Morrow (2008) reveals that Black students, with poor qualifications and financial constraints, are likely to be excluded, as merging various universities does not address the dissimilarities in the educational preparation and financial backgrounds of students.

In light of learning development, new conditions enhance the transformation of the HE system, enabling learning to contribute to the collective progress of students, through the construction, achievement and request of knowledge, the building of students' ability, and the opportunities of lifelong learning occasions (Joyce & Showers, 2002; Sahlberg, 2006). Therefore, the qualities of learning statistics attempt to develop ways of thinking, as well as plans that help students to process information, plan study activities, monitor their attention and sustain a motivation for learning statistics (Brophy, 2013).

Quality learning means preserving and applying academic, as well as educational standards (Laurillard, 2013). The principle of specific expectations and excellence are targeted (Kistan, 1999; Cartwright, 2007). Nevertheless, these potentials and principles differ from one context to another, partly depending on the detailed commitments followed (Bitzer, 2004). Applying the principle of quality involves assessing procedures and outcomes against conventional standards, while aiming at improvement or progress (Biggs & Collis, 2014). All inquiries in statistics are scheduled around significant requests. The two questions for FET are: "How do students appreciate their world today?", and, "What heritages of the past have formed their present?" (Merriam, Caffarella & Baumgartner, 2012).

In relation to the principle of quality, an effective learning system leads to preferred endings (Chenhall, 2005; Biggs & Tang, 2011). An efficient learning system does things appropriately in terms of building best use of existing means (Murgatroyd, 2011). The promotion of efficiency is the central focus to combat equity issues that are still largest in the higher education. For example, Afrikaans universities, such as Stellenbosch University would be required to deal more courses in English, to allow access to Black students (Woodrooffe, 2011; Cloete, 2006).

Early 2004, new universities were recognised, with the following recommendations, to create ethical environments and provide multiple training opportunities (Workshops, conferences, oral presentations), to maximize the students' ability to integrate in their academic environment, and to facilitate their social cohesion (Woodrooffe, 2011; Cloete, 2006). The application of merging universities has negative consequences, despite prerogatives of restructuring higher education to address the disparities of the past. Therefore, historically white universities opposed this merging policy with black institutions, as they were of the opinion that it would reduce the quality and efficiency of their institutions. However, some institutions remained intact, because the improvement in their proficiency and practicality, relative to the apartheid legacy, was observed (Cloete, 2006).

Regarding attitudes and emotions, the presence of different ethnic groups does not promote positive relationship building (Woodrooffe, 2011; Cloete, 2006). Ethnic relations continue to deteriorate in some institutions, such as Stellenbosch University, for example (Leibowitz, Van Schalkwyk, Ruiters, Farmer & Adendorff, 2012; Hall, 2015). Consequently, the likelihood of inter-ethnic tensions in higher education may increase once the immediate needs of the different ethnic groups are effectively addressed (Woodrooffe, 2011). The perception of fair usage across the HES informs required behaviour that can promote social cohesion among all South African students [at a national level] (Woodrooffe, 2011; Hungwe, 2015).

Several studies are focused on learning statistics at Universities and colleges. There have matched different instructional approaches, with the frequent results which are imperfect to the particular courses involved. These results could not be generalised to other courses (Mvududu, 2003; Biggs, 2011). Other research studies, while not comparing instructional methods, have recommended some practical inferences for monitors (Nicol & Macfarlane-Dick, 2006). A logical reasoning about important statistical thoughts can be established very cautiously, using actions and tools, given enough time to review these concepts (Garfield & Ben-Zvi, 2008).

3.6. Issues and Challenges of Learning Statistics

Educational performances differ because of a number of considerations, such as individual characteristics, emotion, behaviour, as well as environmental factors (Anable, 2005). Such factors obstruct the learning process in the HES. Experience is one of the characteristics that enhance learning statistics.

One of the issues affecting the learning process in middle school is, the students cannot fully conceive probability, until they understand the different concepts of it, with its approaches and relationships (Jones, 2006). Exploring these approaches, results in various conceptions of probability. In addition, the notion of distribution and the law of large numbers are central constructs in the learning of probability at this level. However, these key ideas are often avoided in order to make probability more accessible. Supervisors are supposed to design tasks that focus on the use of distribution and the law of large numbers. This enhances the students' ability to make valid probability predictions, in the context of random events, which is important for students to appreciate that understanding probability is about understanding randomness (Garfield & Ben-Zvi, 2008).

Another issue is age related. Postgraduate students find statistics learning difficult and acknowledge the ineffectiveness of traditional ways of lecturing (Garfield & Ben-Zvi, 2007; Biggs, 2011). The reason for this is that traditional ways of lecturing rely solely on the curriculum, instead of the real life problems. Postgraduate students do not seem to be comfortable with seminars/tutorials as opportunities for learning (Brockbank & McGill, 2007; Nightingale & O'Neil, 2012). Students also do not interact well with their colleagues; therefore, they fail to benefit from the advice offered by fellow peer students (Brophy, 2013). Riding & Rayner (2013) reveal that students learn better when observing challenging tasks (application work in statistics). This can be done through practicing their communication skills, and integrating, as well as applying their statistical knowledge to write-up their report

(Burbules & Berk, 1999; Kolb & Kolb, 2005). Students are more likely to develop the capacity for critical thought, when they are challenged by activities, as well as by reflective supervisors, who help them to explore these experiences about their world (Kolb & Kolb, 2005; Prince & Felder, 2006).

The third issue relates to facilitators and researchers. For statistics learning to be more effective and less fearful, facilitators and researchers need to focus on the beliefs and attitudes, developed during their educational experiences (Gal & Ginsburg, 1994). Often, facilitators do not know how to penetrate the belief systems of students, and, therefore, fail to influence the students to appreciate the course. The assessment of the attitudes and beliefs of students, enable educators to understand the presumptions, and identify specific areas of the students' frustration. The focus of new vision is to improve the assessment of learning statistics that cope with effective strategies to overcome challenges (Bryson, 2011). Garfield *et al.* (2007) also assert that students compute probability, chance and random events correctly, but the persistence of misconception, appears in the application of these main concepts, in the concrete context that reveal the students' misunderstanding.

Related to the above issue, is the expectation of students that the application and usefulness of statistics are often not met, leading to anxiety. Gal and Ginsburg (1994) argue that students disempower themselves, instead of following examples with commentary, which highlight guidance to improve their learning. This initiates a tendency to return to traditional ways of learning, and, therefore, obstructs creativity. The complexity of many statistical ideas, assumptions and rules, constitute major challenges for students. With poor mathematical skills (proportions, decimals and arithmetical formulas), students encounter difficulty in learning statistics content and often confuse the With poor mathematical skills (proportions, decimals and arithmetical formulas), students encounter difficulty in learning statistics content and often confuse the dual role that the average plays as both a number and a random variable (Martin, 2003; Garfield *et al.*, 2007). The completion of average is done randomly. Many students are not aware of that. However, an average is the consequence of a formula which lies in sampling variability. Students are not familiar to this concept. Perhaps it is the way students think about data that causes them to fail in confusion. Most students accept easily that large samples lead to better inferences; therefore, the availability of more information exists in a larger sample. It is not sufficient; there should be less variability (in the average) from larger samples (Lin, Lucas & Shmueli, 2013). Students do not certainly compare “more information” with “less variability”. They simply do not think about how the average might behave, if the sampling were repeated frequently (Martin, 2003; Garfield *et al.*, 2007). They are able to study statistics as a particular subject, rather than some of the courses on offer, which explore the deeper recesses of probability theory.

According to Ben-Zvi and Garfield (2004), an increase in learning statistics does not affect the perception that many students have of the statistics course, namely, a difficult, frustrating and unpleasant course to learn. These problems mislead the students; therefore, their experiences are based on wrong perceptions, errors and misconceptions that do not provide an appropriate answer, or allow them to choose a correct statistical method. When confronted with uncomfortable and tainted data, students do not want to think beyond the content, given that potential elucidations are founded on different expectations (Ben-Zvi & Garfield, 2004).

The manipulation of data requires randomness, to avoid bias in the application (Demšar, 2006). This concept of randomness remains a challenge for many students. However, it is important to notice that probability is likely about events that are just as unplanned. The prediction of an event does not mean that the occurrence is assured; therefore, it is reasoning under uncertainty (Savard, 2010). The use of prediction, as a way of revealing the outcome with certainty, is wrong; given that it depends on randomness. Similarly, everyday events occur randomly, which makes the study of possibility a little more concrete. Informally, a random event is a member, or subset of the sample space (Shapiro, 2009).

The increased student diversity in academic settings affects achievement outcomes (Schunk & Pajares, 2010). Postgraduate students originate from different cultural backgrounds and have different understandings of writing and presentations. In the area of learning, they should approach new ideas, or concepts, critically and analytically. Some interpret these approaches as different from their previous academic environment. Bandura (1986) also acknowledges that student’s self-efficacy can be affected by his/her behaviour and contextual factors. It is essential to know how students combine the influence of new contextual factors and their prior experiences from previous academic settings, to achieve relevant self-efficacy judgments (predictions). These new social factors include a low perceived value of the learning setting, as well as the perception of autonomy. Facilitators, parents, peers and supervisors contribute to students’ self-assurance. It is noteworthy that, students with great levels of self-efficacy for learning, but who feel separated from the university environment, may score little in inspiration and accomplishment (Brophy, 2013). A clear challenge is to determine how self-efficacy with social factors influence on academic completions.

Learning involves the construction of knowledge (Novak, 2010). Garfield *et al.* (2007) assert that facilitators are aware of the procedures and methods. Students are not able to practice on their own. They often need impelling, as well as the monitoring of their ability to do, and to discern. They need to be encouraged and reassured. According to Ben-Zvi and Garfield (2004), the ability of students to think and reason statistically has not been achieved yet. Students have to apply their minds to think critically by reading articles, or books, for example, given that during their undergraduate studies, learning approaches were more passive, as receivers of knowledge. They rarely argued about anything that should be implemented in their lives. Students should continue to apply their minds to think critically, until they are confident enough. The self-confident judgment in reflections appears like an original sense of the individual's early experience. The challenge of different attitudes to learning could offer the postgraduate a possible approach to the issues of critical thinking. Therefore, the integrity of international education is preserved.

In addition, the practical challenges involve a new academic research difficulty to conceptualise, for instance, how to organize the presentation of an academic writing; specifically, the order, the steps between tasks, paragraphs, sub-topics. A good order in a specific work enables a reader to follow and understand easily. In addition, the feedback with fewer questions could be expected, as well. A lack of understanding, regarding the framework and structure of different kinds of tasks, should be avoided (Laurillard, 2013).

Students learn with processors, but are tested without computers, as it is in many other courses. However, the introduction of technology in statistics education increases the need for thoughtfulness to the individual student's concerns and reaching (Ertmer, 1999; Tam, 2000). But the challenges arise regarding when and how to use computers in meaningful ways. The way in which computers are used introduces the failure that obliges monitors and students to rethink their approach of teaching and learning. If supervisors need technology to complete student outcomes, they also require abilities for designing, choosing and adjusting software, determining plans that make use of its technology.

Finally, the issue of calibration complicates the role of self-efficacy in learning settings. There are factors that can affect student's self-efficacy differently, than the ways in which they affect their learning and performance on the corresponding tasks (Pajares & Kranzler, 1995). When students assess that they are proficient of performing a task, and perform it, or when they judge that they are capable of accomplishment it, and cannot do it, they are well calibrated, because self-efficacy accurately predicts achievement. Conversely, when students judge that they are capable of executing a task, but do not perform it, they are poorly regulated, because of the deficiency of correspondence between self-efficacy and performance. In fact, calibration is necessary, but complicated, in academic settings. Students, who overestimate their ability, may sometimes fail, which could reduce motivation. Those who underestimate what they can do may be unwilling to try the task, and thereby delay their skill acquisition. Self-efficacy judgment that slightly exceeds what a student can do is desirable, because such overestimation can increase determination and perseverance, but recurring overestimation could lead to constant failure, with resulting decrements in the students' motivation to learn (Bandura, 1997).

3.7. Synthesis and Partial Conclusion

The literature review revealed that most of the research, conducted on the topic, were based more often on assumptions and documentary reviews, than data analysis of the determinants of statistics learning (Johnson & Christensen, 2010; Ary, Jacobs, Razavieh, Sorensen & Walker, 2013). However, a few existent researches examined the problem with very simple and limited analysis methods, and only very rare papers, or articles, concentrated on multivariate analysis of the phenomenon (Meyers, Gamst & Guarino. 2006; Izenman, 2008). Two principal approaches emerged from the literature. Some authors believe that prevention measures of statistics-learning-related difficulties are not robust enough to curb the trend of the level of knowledge, understanding and skills; therefore, emphasis should be given to adequately solve difficulties. The idea is that mis-understanding, or mis-perception related frustrations can never be avoided totally, whatever the dispositions taken (Kolb, 2014). It is very difficult to detect, or suspect some distortions, even with participation in workshops, seminars and conferences.

Conversely, other authors are of the opinion that, for a long time, privilege has been given to postgraduate students to reduce direct statistics anxiety, for instance, as the result of confusions, lack of knowledge and skills. Therefore, these authors are in favour of giving priority to postgraduate students to participate in workshops, seminars and conferences on statistics ability [prevention approach] (Bisgaard *et al.*, 2008; Wood, 2010). Researchers, who support the prevention approach, believe that implementing actions, to avoid failure in SELS beliefs among students with difficulties, is realistic in the short and mean term (Johnson & Christensen, 2010). In universities, such as UWC (with a high concentration of black students from disadvantaged areas), adopting a policy based on providing well organised assistance in statistics services, freely accessible to students (along with well-trained statistics monitors, and developing consultations with peers), could be helpful to achieve the desired outcomes, with special regard for the financial constraints of these students.

The main difference between the two approaches is the period of effectiveness. Some recommendations could have immediate effects, but need unrealistic financial means to implement in short or mean terms (Pattillo, 2013). Others are slow to action, but could be implemented with relatively modest financial investment. In general, there is consensus about the importance of using both prevention and direct intervention approaches to statistics difficulties (McCardle, Scarborough & Catts, 2001; Dunlap *et al*., 2006).

From the writings review, it is perfect that most analyses only focus on identifying the explanatory factors of SELS beliefs failure, without considering the path through which the influence occurred (McCarthy & Rogerson, 1992). In fact, very few studies explored the complex mechanisms of the actions of SELS beliefs predictors. In addition, almost no study, currently has attempted an analysis of SELS beliefs failure at universities in South Africa, or provided specific recommendations for a regional scale (Coetzee & Van der Merwe, 2010; Mji, 2009). This study aims to provide scientific recommendations for actions against SELS beliefs failure, adapted to particularities of the UWC, UCT and its regions.

CHAPTER FOUR

RESEARCH SETTING AND METHODOLOGY

4.1. Introduction

In this chapter, the researcher describes the research setting and the methodology used in this study. A brief background of the universities involved in this current study, the University of the Western Cape (UWC) and the University of Cape Town (UCT), where the data were collected, is firstly provided. Subsequently, the researcher discusses the research design (a combination of both quantitative and qualitative research), sampling procedure, sample size, pilot survey, data collection instruments, data collection technique, description of the variables, data analysis procedures, limitation in the methodology, data interpretation, ethical consideration, reliability and validity of the data collection instruments.

4.2. Academic Research Profile

Research is a central priority for higher education in the knowledge era. Research has been a valuable element for many academic institutions and systems (Ben-David, 1968; 1977). Therefore, it is an academic activity, which refers to a careful investigation, in search of relevant information and new facts in any branch of knowledge. Research extracts the experiences of students in their academic programmes, at their institutions of study (Healey, 2005; Evans, Forney, Guido, Patton & Renn, 2009). The new educational goals and objectives of diverse higher education pursue the same objective of aspiring to be an academic research university (Badat, 2010). Academic research must promote the knowledge, abilities and skills that allow graduates to contribute to development, in general, since such expansion can help initiatives geared towards better fairness and social progress (Badat, 2010).

Successful supervision seeks to understand the experience of students, as well as the environment in which they execute their academic work (Cadman, 2000; Phillips & Pugh, 2010). When students learn to leverage information and communication, in order to collaborate, organise, create, generate and re-purpose, they become fluent in applying knowledge, such as statistical procedures (Phillips & Pugh, 2010; Boud, 2012). However, this current study aims to clarify students' concepts of postgraduate learning, by identifying a critical understanding of their academic work, in different implications. South African universities have emphasised change under the post-colonial government (Di John, 2010). The change seeks to address inequities, which relates to the fact that "white" universities were discriminatory towards its population. South African universities, therefore, with its new environment, focus on issues of transformation.

These issues are the higher education heritage of apartheid, perceptions of the role of universities, the impact of the mutable racial profile of student, the integration of members of the black community into the public and private sectors, as well as the negative implications of the African brain drain from universities for civil society (Cloete, 2006). UWC has shared common financial issues with other black universities. In addition, these universities have been providing academic support services, in order to sustain success in the case of disadvantaged students, particularly those administered by the Department of Education and Training (Renn, 2014).

Given that universities are the centres of the knowledge and information, they are the most important units of the production and consumption of knowledge in developing countries (Teferra & Altbachl, 2004). Universities in the HES of South Africa vary, in terms of their academic, administration and financial arrangements. Those with multiple campuses, focus on undergraduate and postgraduate education, conduct research and offer distance education programmes. Higher education comprises all post-secondary education, beyond grade twelve, in different subject areas, such as engineering, agriculture, languages, mathematics, medical, chemistry, education, technology and others (Pillay, 2010). This current study focusses on postgraduate studies only, with three levels of qualifications, namely, Masters, Doctor of Philosophy, and post-doctoral programmes. The HES in the Western Cape has seen an impressive growth since the advent of democracy, with the democratically elected government setting up a private sector of institutions, through legislation (Butler, 2017).

4.2.1. University of the Western Cape (UWC)

The University of the Western Cape (UWC) was recognised in 1960 as an ethnic college for "coloured" students, and was only accorded full university status in 1973 (Keats, 2009). In 1978, its council rejected the ideological basis of its origins, and in 1983, the institution gained independence from direct political control (Keats, 2009). The UWC has played an essential role in South Africa's freedom struggle against coercion, discrimination and the disadvantaged. Under the leadership of Rector Prof. Jakes Gerwel, during the 1980s and 1990s, the university declared itself ‘an intellectual home for the left’. This intonation implied a deep academic appointment with the issues of autonomy and democracy, in order to make for the post-liberation democratic political dispensation that was coming (Russell, 2009). Under the Rector Prof. Brian O’Connell, the UWC emerged from a difficult period, both financially and the notion of an “engaged university”, in which the concept of “engaged” implied a deep intellectual engagement with the challenges of current times. One of UWC’s challenges is, continuing to appreciate and advance the democratic ideologies of liberty, as well as social justice (Keats, 2009).

Consequently, the university is decisively slanted towards the future, “committed to excellence in teaching, learning and research, to promoting the cultural diversity of South Africa, and replying to the requests of society”, while being aware of its unique academic role in assisting to shape an equitable, quality in higher education and active nation (UWC Mission Statement, 1997). Within the UWC, concepts such as liberty and freedom are deeply entrenched in its established philosophy, and the university continues to engage with the issue of what it means to be free in a democratic state (Keats, 2009). The notion of freedom embodied in concepts such as, free software, free culture, free content, and digital freedom, resonate well with South Africa’s history and its institutional culture (Moore, 2003).

The academic departments of UWC are divided into seven faculties; Arts, Community and Health sciences, Dentistry, Economic and management sciences, Education, Law and Natural science; with each faculty is headed by a Dean. Institutions accredit learning levels achieved (Keats & Schmidt, 2007), rather than only knowledge acquired through formal courses. Institutions are aligned with a framework of autonomy and openness, in order to maintain quality, while moving into this space. In Africa, where the existing academic specialisations in any institution is limited, this kind of explicit and implicit collaboration will show vital, if UWC is able to achieve the prospective of higher education on the continent (Kraak, 2000).

4.2.2. University of Cape Town (UCT)

The University of Cape Town (UCT) is a public research university, by a private act of Parliament, in 1918 (Phillips, 1993; Atkinson, 2010). UCT was established in 1829 as the South African College and is located in Cape Town, in the Western Cape Province of South Africa. UCT is the highest-ranked African university in the Academic Ranking of World Universities. The language of instruction is English.

In 1874, the South African College Schools, teaching up to secondary level, were separated from the College, which prepared students for the examinations of the University of the Cape of Good Hope. In 1918, the South African College was elevated to full university status, with the authority to award degrees, and renamed the University of Cape Town. UCT campus is split into three: Upper Campus, Middle and Lower Campuses. They are spread throughout the suburbs of Rondebosch, Rosebank and Mowbray (Phillips, 1993; Luescher, 2009).

Since 1997, UCT is controlled by an institutional statute issued under the provisions of the Higher Education Act No. 101 of 1997 (UCT, 2010). The current executive head of the university is the Vice-Chancellor, Dr Max Price, who replaced Professor Njabulo Ndebele on 1 July 2008. The academic departments of UCT are divided into six faculties: Commerce, Engineering and the Built Environment, Health Sciences, Humanities, Law, and Science; each faculty is headed by a Dean (Republic of South Africa [RSA]. Department of Higher Education and Training [DoHE], 2002). The multi-disciplinary Centre for Higher Education Development rates on a level equal to the faculties. Although the Graduate School of Business is considered to be part of the Faculty of Commerce, it is administered independently and has its own Dean and Director (Pillay, 2010).

UCT strives to provide a superior quality educational knowledge for postgraduate students, by providing an intellectually and socially stimulating environment, inspired and dedicated to learning, as well as exposure to the excitement of creating new knowledge and stimulating the love of lifelong learning (Nygaard & Holtham, 2008; Mwanza, 2011).

4.3. Type and Perspective of the study

The implementation process of the educational policy on statistics learning has to consider certain assumptions. Firstly, the complexity of the policy process initiates an investigation into the perspectives of the participants' diverse backgrounds. Secondly, strong policy goals, operational guidelines pressure, support from the higher educational environment and effective interaction between higher education and the context, enables effective policy implementation.

The real advantage of being a post-graduate student was that the researcher could gain easy access to the different departments involved in the study. In addition, the relationships developed with some of the participants over a period of 3 years, meant that trust was firmly established. This was a positive factor, as these participants were familiar with the researcher, which encouraged them to provide as much information as they were able to, and enabled them to understand the context in which its claims were made during the interviews. However, negative elements could emerge during the interviews, especially when the participants elected to express their anger and frustration about the processes, instead of focusing on the research questions. Some students had the tendency to use this opportunity to communicate their dissatisfaction about issues arising from the implementation of learning statistics.

4.4. Design of the study

The design of the study employed quantitative and qualitative methods. Kalinowski, Lai, Fidler and Cumming (2010) acknowledge the value of mixed methods research and the use of extensive data collection, which promote concentration on a better understanding of an established area of statistics education, as well as new areas of research. However, quantitative purists maintain that social and behavioural inquiry should be objective, based on positivism; while qualitative purists argue that it is impossible to differentiate the causes and effects fully, as well as that logic flows from specific to general (Guba, 1990). Understanding leads to the examination of many different variables, such as anxiety, attitude, environment, experience, behaviour and culture (Agarwal & Prasad, 1999; Ho & Kuo, 2010).

A quantitative cross-sectional survey was employed in this current study. Burns and Grove (2005) define "quantitative research" as an organised method, in which numerical data are applied to get evidence around the world. This exploration process is applied to define attributes, to inspect connections between attributes, and to investigate reason and consequence connections among variables. Additionally, Babbie and Mouton (2001) describe quantitative research as a formal method of collecting information systematically and objectively, and involves the analysis of numerical data. Its primary goal is to categorise structures, sum them and build numerical representations in an effort to clarify what is perceived.

Similarly, Groth (2007; 2010) emphasises the importance of using a qualitative research method for diverse reasons in statistics education research, including, creating space for new ideas, allowing the participants to provide their own perceptions, and investigating emerging areas of research. Gelo, Braakmann and Benetka (2008), as well as DelMas (2004; 2011) assert that the valuable role of qualitative research methodology in statistics education, which allows the development of hypotheses as part of the research process, is to mature an adequate theory, according to the observations that have been made.

The most appropriate type of investigation strategy for this current reseach was a causal research strategy, because, according to Malhotra (2009), fundamental investigation is "a type of decisive investigation, where the main goal is to get indication, regarding reason-and-consequence (causal) connections".

4.5. Justification for Mixed Methods

The choice of implementing a diverse technique plan in this current research was guided by the fundamental assumption that it would provide a wider appreciative of the investigation enquiry, than either "qualitative" or "quantitative" approach individually (Teddlie & Tashakkori, 2011). In addition, the issues of learning statistics, as well as the application of the equity, quality and socialisation aspects in academic research, include multiple constructions and interpretations of reality. Therefore, the mixed method enables the understanding of complex problems, such as knowledge development and the approaches to studying in postgraduate programmes (Creswell, 2013). Besides, each of these methods has its own strengths and weaknesses. The combination of qualitative and quantitative strengths would sustain the vulnerability of this mixed method, which would enable the expansion of a complete appreciative of queries' investigation (Creswell, 2014). Weaver-Hightower (2014) argues that the practice of "qualitative method" only possibly will impede the process of establishing the full scope of the enquiry's exploration, while the use of "quantitative method" only may impede the process of ascertaining the contextual meaning of lived experiences related to the enquiry exploration.

The quantitative analysis aims to quantify and examine the levels of knowledge, by applying statistical procedures among students' individual characteristics, across behaviour, as well as social support. It is during the quantitative phase that a relationship between the student's ability and other variables, such as individual characteristics, behaviour, and social support is identified. In addition, the determination of factors that significantly predict the student's self-efficacy to understand/interpret statistical procedures is constructed. Ultimately, it follows the identification of aspects of students' experiences, which may be improved by sharing good practices via expertise with supervisors and peer students (Nicol & Macfarlane- Dick, 2006; Falchikov, 2013).

During the second step, qualitative interviews are conducted in selected sites. A researcher conducts semi-structured interviews, specifically, to explore the knowledge of post-graduate students, when applying statistical procedures in their academic research. After the semi-structured interviews, the variables or indicators, suggested by the students as sound descriptors of learning statistics, are thematised (theme frequencies). In this current study, the qualitative phase explores one of the research objectives. This phase contextually examines a body of empirical results that characterises different situations (cultural domains analysis) and develops precise theories that explain and predict observed data. The perceptions and dynamics of learning are social constructs; therefore, the motivation for using qualitative techniques to explore these constructs, helps researchers to interpret the meaning of the social phenomena under investigation, from their context worldview, because both students and their institutions are linked, historically and materially (Moore & Kearsley, 2011). Denzin and Lincoln (2011) concur that qualitative techniques enable researchers to understand the processes and dynamics of a social reality, such as learning statistics, because, they believe qualitative techniques generally involve open-ended questions, which provide participants with the opportunity to express their view freely and openly. These authors also argue that the qualitative research method can be stretched and shaped to fit the purposeful acts of social actors.

In the context of this current study, the qualitative techniques enabled the researcher to interpret learning statistics, based on the students' understanding of it, as learning is culture-related. It is for this reason that the researcher believes qualitative techniques are more appropriate, because they allow the participants to express both their perceptions and experiences of learning statistics, freely.

Regarding the mixed methods data analysis, the convergent, parallel, mixed methods design is applied in this current study. In terms of this design, both quantitative and qualitative data are collected and analysed separately. Subsequently, the results are compared to ascertain whether the findings either confirm, or do not confirm each other (Creswell, 2014). Considering the complexity of both sources of data and data analyses, the mixed method provides the opportunity to assess different views in the conclusions and inferences made by the study (Teddlie & Tashakkori, 2011). It is important to note that the mixed method design does not necessarily seek convergence of the research results, but it could exist. In fact, according to Teddlie and Tashakkori (2011), an important result of combining information from different sources is the divergence or dissimilarity, which, in turn, may provide greater insights into the complex aspect of the same phenomenon, and/or the design of a new study, or phase for investigation. The use of both quantitative and qualitative techniques is complementary.

Luyt (2012) supports the combination of quantitative and qualitative methods and argues that the combination increases confidence in the research findings, when the data is consistent. Guest (2013) argues that a study gains legitimacy from the strength of the research design, the use of a convincing argument and the transparency of the research process. According to Natasi, Hitchcock & Brown (2010), mixed methods design is a useful approach, even if the issue remains challenging. Explaining these concepts into a pattern for this current study, implies that neither quantitative, nor qualitative methodology alone, is integrally superior, but that they both play a role in the construction of knowledge, contingent upon the form of information that is being required.

Schwandt (2014) acknowledges that qualitative research allows researchers to obtain insights into particular educational, social, and practical realities, which apply in a specific context. Qualitative research highlights how people exchange meaning, which enables researchers to gain insights, as they seek to excerpt sense from their data. Being aware that a physical action has diverse meanings for different students, the significance of the action cannot be explained sufficiently, in terms of behaviour. A significant finding in qualitative research, therefore, is one that has sense, or illustration (Johnson & Christensen, 2010).

According to the interpretivists, a particular human behaviour needs a specific intentional content that indicates the type of behaviour, which can only be understood in terms of the system of meanings to which it belongs (Scott & Usher, 2010). Therefore, for interpretivists, in order for a human behaviour to be explicated, the meaning that underlies that behaviour must be understood. In addition, interpretivists contend that the individual meaning of action can be understood in an objective manner (Schwandt, 2003). Three steps that elaborate the "analysis of meaning" must be reconstructed, namely, noting conceivable meanings in field notes, renovating normative factors, and the subjective states of the individuals. These steps help the researcher to find significance in the data (Cooper, 2014).

Regarding ethnographers, their particular interest is focused on cultural connotations that stem from the interactions of groups (Silverman, 2006). They study how cultural meanings might be replaced and transferred, because of intercultural efforts to find solutions to problems. After justifying the rationale for accepting a mixed method design for the purposes of this current study, the following sections focus on the research design and process.

4.6. Quantitative Research Design

4.6.1. Uni-level sampling

In the academic system, the students constitute the lower level and the universities, the higher level. Students interact with their social contexts (faculty/department), suggesting that students are influenced by their academic environments, or contexts, and that the properties of those contexts are, in turn, influenced by the individuals, who make up that context. However, the students and the academic environment are conceptualised as a hierarchical system, with the individuals and faculties, or departments, defined at separate levels of this hierarchical system (Zimmerman & Schunk, 2012).

Commonly, the achievements of the students are revealed as the result of a combination of individual characteristics (predisposition and enabler), as well as behavioural and environmental factors. Multivariate models are not suitable for the analysis of such hierarchical systems, even if the analysis comprises only variables at the lowest (students) level, because their individual observations are, in general, not independent (Harrell, 2015). Additionally, the observations are not distributed in the departments, usually. Although, the consequences of using uni-level analysis methods on multi-level data are well known, it has been applied in this current study. The parameter estimates are unbiased, but inefficient, which results in external significant effects (Maas & Hox, 2004).

In the context of this current study, a uni-level sampling procedure was followed at the two universities involved, namely UWC and UCT. The standard statistical procedures guided the sample selection process of the students. According to Creswell (2014), three factors often guide the selection of a sample, namely, the estimated prevalence of the variable of interest (self-efficacy to learn statistics), the desired level of confidence and the acceptable margin of error. Therefore, based on these three elements, the required sample size was selected, according to the following formula:

$N \geq [t^2 * p\ (1 - p)] / m^2$

Where: N= required sample size

t= confidence level at 95% (Standard value of 1.96)

p= estimated prevalence of learning statistics in the research area (25%).

m= margin of error at 5% (standard value of 0.05)

The required sample size was determined as follows:

$N \geq [1.96^2 * p\ (1 - p)] / 0.05^2$

$\geq [3.8416 * 0.25\ (1 - 0.25)] / 0.002$

≥ 288.12

Ultimately, 307 of the 400 questionnaires that were distributed across both universities, were successfully completed, which represented a 76.75% response rate, against a 23.25% non-response rate.

4.6.2. Sample of respondents

The target population of this current study comprised all the MA, PhD and Post-doctorate students, registered for postgraduate programmes, on a part time or full time basis, in natural, behavioural, and social sciences at UWC and UCT. Johnson and Christensen (2010) describe a sample a set of elements retrieved from a population based on certain characteristics. The simple random sampling or the probabilistic sampling option was applied; therefore, each member of the sub-population in each department had the same probability of being included in the sample.

Regarding the sampling process, 200 students were randomly selected from the various natural, social and behavioural sciences departments of each institution (UCT & UWC), so that the results could be generalised to this identified population (external validity). Ultimately, 156 students from UWC fully completed the questionnaire, signifying a 78% response rate, and 151 students from UCT signifying a response rate of 75.5%. The participants were drawn from different campuses of their institutions.

4.6.3. Research instruments applied

For the determination of this work, the six instruments employed dealt with cognitive issues (self-efficacy); beliefs (statistics anxiety); students' behaviour (attitude toward statistics); an adequate environment that provides social support to students; demographic information and experiences in statistics and research methodology; and also a list of qualitative questions. Bandura (1977) describes SELS beliefs as an individual's decisions of his/her abilities to structure and perform means of action required to achieve precise kinds of findings. According to Bandura (1977), four factors determine the self-efficacy principles, which include personal relevance (performance outcomes), uncertain learning experiences (vicarious experiences), critical voice (verbal persuasion) and emotional stimulation.

The *SELS scale* has 14 items, with a 6-point Likert response scale ranging from one "1=no confidence at all" to six "6=complete confidence". In addition, it has two forms: the "preferred" form measures the desired ability of an individual to learn statistics, while the "actual" form measures the perceived current ability of the individual to learn statistics.

Subsequently, the “*Statistics Anxiety Rating Scale” (STARS)* was applied in this current study to describe the concept statistics anxiety. The STARS is a multi-dimensional instrument with six components of statistics anxiety, namely, “Worth of statistics”, “Interpretation anxiety”, “Test and class anxiety”, “Computational self-concept”, “Fear of asking for help” and “Fear of statistics monitors”. It has 51 items, with a 5-point Likert response scale ranging from one “1=no anxiety” to five “5=very much anxiety”. These items are divided into two groups (23 items relate to statistical anxiety, while 28 items are statements related to statistics). Onwuegbuzie and Wilson (2003) assert that three variables are related to statistics anxiety, which include previous situations or experiences, the disposition of the student or the absence of adoption for the meaning of the logical simulations, and the environment or absence of rational descriptions among social students.

Student behaviour is measured by using the “Survey Attitudes Toward Statistics scale” (SATS), which comprises 36 items, with a 7-point Likert response scale ranging from one to seven. Using the 7-point response scale, higher scores correspond to more positive attitudes. SATS is divided into two subscales: “attitudes toward the field” and “attitudes toward the course”. Therefore, the first subscale describes students’ behaviours toward the practicality of statistics in their field of study, while the second component measures students’ performance toward the statistics courses they are attending. Furthermore, attitudes toward the field comprise 8 items (“Interest”: 4 Items and “Effort”: 4 Items). Also, attitudes toward the course include 28 items (“Affect”: 6; “Cognitive competence”: 6; “Value”: 9; “Difficulty”: 7) (Wise, 1985).

The “*Multidimensional Scale of Perceived Social Support variable” (MSPSS)* measures an adequate environment and includes three subscales, namely support from “significant others”, support from “family members”, and support from “friends” (Zimet, Powell, Farley, Werkman & Berkoff, 1990). The MSPSS has 12 items, with a 7-point Likert response scale going from one “1=very strongly disagree”, to seven “7=very strongly agree”.

In addition, *a demographic questionnaire* was applied to gather evidence related to the respondents’ aspects (age, gender, ethnic groups and marital status), their previous experiences (statistics and research methodology) and academic institutions, with academic factors, such as department, post-graduate programme, type of study and student status.

Finally, a *qualitative instrument* is applied to capture the strategies of students to make appropriate choices of statistical procedures and the content of what they perceive statistics to be.

4.6.4. Pilot survey and its results

The pilot was a prospective survey with 37 postgraduate students from the two universities (UCT and UWC). The pilot test was a crucial part of this current study. The respondents were MA, PhD and post-doctorate candidates (inclusion criteria). The pilot study was specifically aimed at guaranteeing the rationality and the consistency of the four instruments, including experiences and the STARS, SATS, MSPSS and SELS. This test was also conducted to confirm that the items were obviously expressed and that the students understood the opinion poll correctly (Grant, 2011). No data were collected before detailed information was provided to the students and signed informed consent was obtained. After the students finished the experimental survey, they were asked to answer response, concerning the experimental test. For instance, they were requested how long they spent to complete the test, whether they found the questionnaire items perfect or unclear, whether any perfections should be completed, as well as whether the survey captured all the relevant information, to assess the knowledge regarding learning statistics of the real student's world, with its university conditions.

The researcher collected the pilot questionnaires once they were completed. The main issue concerned the inner reliability of the scales. This refers to the degree to which the items that made up the scales 'hang all together'; for example, determining whether they were all measuring the same underlying construct. The consistency of a scale could diverge reliant on the sample; therefore, it was required to check that every scale was reliable with the pilot's sample. Table 4.1 indicates the results of the internal validity of the four instruments per factors. Ideally, the "Cronbach Alpha coefficient" of a scale must be beyond .7 (Pallant 2013). In this case, the majority of factors and its components scored Cronbach Alpha coefficients greater than .80, suggesting a very good internal validity and consistency for the scale with this illustration. Values above .7 are deliberated acceptable; nevertheless, values above .8 are better. The component test reported the smallest Cronbach Alpha coefficient (.552). Given that the scale was established and validated in previous studies, for reason of comparison of results, there was no need to consider removing this component test from the scale. The mean inter-item correlation for the component test was .38, with values ranging from .01 to .82. This suggests an excellent construction among the items.

Table 4.1: Cronbach Alpha coefficient results of the preliminary instruments

Variables			No Items	Cronbach's Alpha	Cases
A. Experiences			6	0.828	37
1	Research methodology		3	0.744	37
2	Learning statistics		3	0.858	37
B. STARS			51	0.927	36
1	Situations associated to Stats		23	0.843	36
	1.1	Test	8	0.552	37
	1.2	Interpretation	11	0.921	36
	1.3	Ask for help	4	0.863	37
2	Statements related to Stats		28	0.970	37
	2.1	Worth	16	0.950	37
	2.2	Teacher	5	0.865	37
	2.3	Self-concept	7	0.877	37
C. SATS			36	0.896	37
1	Affect-Feeling		6	0.764	37
2	Cognitive competence		6	0.668	37
3	Value-Attitudes		9	0.778	37
4	Difficulty-Attitudes		7	0.788	37
5	Interest		4	0.917	37
6	Effort		4	0.947	37
D. Social support			12	0.926	37
1	Significant others		4	0.903	37
2	Family members		4	0.896	37
3	Friends		4	0.868	37
E.1. Self-efficacy (to solve)			14	0.962	37
E.2. Self-efficacy (to learn)			14	0.969	37

After collecting the feedback from the respondents, the researcher carefully read the suggestions provided by them. These comments revealed the items that needed to be refined. The researcher made the corresponding adjustments to the questionnaire items as follows:

Original and revised items in the STARS questionnaire

4. *Original:* Doing the homework for a statistics course.

Revised: Attending a statistical workshop or seminar.

9. *Original:* Reading an advertisement for an automobile which includes figures on miles, per gallon, depreciation, etc.

Revised: Reading a car advert which includes numbers regarding car performance.

10. *Original:* Walking into the classroom to take a statistics test.

Revised: Walking into the room to take a statistics test.

16. *Original:* Asking one of your professors for help interpreting the output from statistical software…

Refined: Asking one of your supervisors or peers for help interpreting the output from statistical software…

17. *Original:* Trying to understand the odds of winning a lottery.

Refined: Trying to understand the probability of winning a lottery.

25. *Original:* I haven't had maths for a long time. I know I'll have problems getting through statistics.

Refined: I have not done maths for a while. I know I will have problems doing statistics.

31. *Original:* I can't even understand seventh and eighth grade maths, how can I possibly do statistics?

Refined: I cannot even understand secondary school maths, how can I possibly do statistics?

Original and revised items in the SATS questionnaire

33. *Original:* I plan to complete all my statistical assignments

Refined: I plan to complete all statistical procedures in the methodology of my academic research.

34. *Original:* I plan to work hard in my statistics course.

Refined: I plan to work hard in my statistical analysis chapter of my thesis.

35. *Original:* I plan to study very hard for every statistics test.

Refined: I plan to achieve my statistics tests related to my research work.

36. *Original:* I plan to attend every statistics class session.

Refined: I plan to attend every statistics workshop or seminar.

However, MSPSS and SELS scales were not refined.

4.6.5. Data collection procedure for the main survey

Ethical clearance and project registration was obtained from the Ethics Committee of UWC (Project No. 15/2/24 on 13/03/2015, Appendix 3), and the proposal was approved and registered by the university's Senate Higher Degrees Committee. Permission to conduct the study at the university was acquired from The Research Office, Department of Research Development (Appendix 3). Similarly, permission to collect data at the UCT campuses, to ensure the confidentiality of the study subjects, was achieved (UCT 30/03/2016 (email); UCT Ref. No - Nil / Faculty: Science Faculty, Appendix 2).

The survey methodology was employed for this current study, using a questionnaire that was distributed randomly to students, to assess the level of their statistics learning in their academic research, and to explore whether any existing factors affected the students' use of statistical procedures. Multiple contacts, or meetings, were arranged with staff members and peer students in selected departments at both universities, to inform them about the surveys. An informative email was sent to selected faculties, advising post-graduate students about the survey. The survey was to be conducted with the postgraduate students to assess how they applied statistical procedures in their academic investigation. The goal of this survey was to answer the exploration questions, and it was designed to obtain information regarding postgraduate students' knowledge, intentions, opinions, attitudes and values. In addition, the survey was flexible, as it was applied to different institutions; therefore, it was suitable for the sample selected (Babbie & Mouton, 2001). The researcher explained the purpose of the research to the respondents. They had to sign a consent form confirming their agreement to participate in the study. The individual respondents' answers were compiled together for capturing in one file (quantitative data).

4.6.6. Definition or Description of variables

Universities share the same variables. Burns and Grove (2009) acknowledge that a descriptive design provides a representation of situations, as they certainly occur. In the context of this current study, the respondents' scores on individual characteristics, behaviours variables, social support and self-efficacy learning during the research activities in an academic environment, were deductively explored and described in tables and graphs.

4.6.6.1. Individual characteristics

Individual characteristics refer to individual differences in characteristic patterns of thinking, feeling and behaving. Only by examining each individual's multidimensional characteristics, the person's learning style can be identified. Individual characteristics affect an individual's decision to adopt a particular attitude (Chakraborty, Hu & Cu, 2008; Rogers, 2010). The role of individual characteristics needs to be clarified, in terms of how the emotions, behaviour and social support of the individual is affected, as well as its correlations with the self-efficacy of graduate students (Schunk, 1991; Wu, Tennyson & Hsia, 2010). Individual characteristics, as a variable, embrace two components, namely, predisposition and enabler. The first component comprises beliefs ("worth of statistics", "interpretation anxiety", "test and class anxiety", "computational self-concept", "fear of asking for help" and "fear of statistics teachers" [Onwuegbuzie, 2000b]), socio-demographic appearances (age, gender, marital status and ethnic groups) and previous knowledge (in statistics and research methodology). The second component includes academic factors (institutions, post-graduate programme, institutions, post-graduate programme, student status and type of study [Bhardwaj & Pal, 2012]).

The component of predisposition includes academic factors, which may influence the likelihood of an individual's needs in learning statistics (Long, 2004). It also includes socio-demographic aspects, which may influence how an individual copes with his/her ability (Altinay, Madanoglu, Daniele & Lashley, 2012). In addition, it could include beliefs, which may influence an individual's perception of his/her need for statistics assistance, as well as life experiences in applying research methodology and statistical procedures. Previous researches have demonstrated mixed results about the effects of age, gender and ethnicity (Coetzee & Van der Merwe, 2010). The post-test scores are reported to be higher, compared to those achieved in pre-tests for females' participants (Chiesi & Primi, 2009; DeVaney, 2010; Kiekkas *et al*, 2015).

Regarding the predisposition factors, the study includes belief, socio-demographics factors and prior experiences. The variables under the belief component are defined with a set of STARS questions that are measured by the statistics anxiety rating scale. For all these questions on this section, the respondent indicates the extent to which he agrees, or disagrees, with each statement. The relevant scale is, No Anxiety = 1, Low Anxiety = 2, Moderate Anxiety = 3, High Anxiety = 4, Very high Anxiety = 5. Cruise, Cash and Bolton (1985) defines statistics anxiety as the emotions of an anxiety come across, when pleasing a statistics course, or undertaking statistical analyses, in terms of assembly, dealing out and interpreting data. Consequently, Zeidner (1991) emphasizes that the absence of self-assurance, and the high anxiety in statistics, restrict many students from appealing in research effort, or promoting an academic occupation.

Onwuegbuzie (1997) defines statistics anxiety as the consequence of coming across statistics in any practice, and at any level, which seems to include a complex array of emotive responses that have the tendency to deteriorate learning. In addition, Onwuegbuzie (1997) acknowledges that the prevalence of statistics anxiety has been detected in both statistics courses, as well as in research methodology courses. Onwuegbuzie, Slate, Paterson, Watson and Schwartz (2000) observed that 75% to 80% of graduate students in the social sciences experienced greater anxiety while performing statistical subjects, which impeded their knowledge acquisition process. Similarly, Pan and Tang (2004) underlined that in social science, students experience intolerable levels of STARS. Huntley, Schneider & Aronson (2000) suggest that statistical investigation developed the lowest educational ability for postgraduate students in the social sciences. Statistics anxiety negatively influences course performance, and has been identified as one of the greatest predictors of success in "research methodology" courses (Onwuegbuzie & Wilson, 2003).

Belief involves six factors, namely, “worth of statistics”, “interpretation anxiety”, “test and class anxiety”, “computational self-concept”, “fear of asking for help” and “fear of statistics teachers” (Cruise *et al.,* 1985). The “worth of statistics” factor determines the importance of applying statistics in the research of the respondent. This factor measures a student’s insight of the worth of a statistics course (Cruise *et al.,* 1985). A student achieving great on this component sees slight or no value in a statistics course, implying that statistics is not considered to appropriate his/her personality, thereby suggesting an adverse attitude towards statistics (Cruise *et al.,* 1985). To evaluate this variable, the following questions 24, 26, 27, 28, 29, 33, 35, 36, 37, 40, 41, 42, 45, 47, 49 and 50 are used.

The “interpretation anxiety” factor refers to the ability to interpret the statistical outcomes, and make an objective decision on which statistical test to use, based on empirical data, or what to do with the null hypothesis. In addition, the anxiety arises from the interpretation of statistical data (Cruise *et al.,* 1985). The interpretation anxiety factor is retrieved from the following questions: 2, 5, 6, 7, 9, 11, 12, 14, 17, 18 and 20. The “test and class anxiety” factor measures the respondent’s anxiety during statistics courses and evaluation (Cruise *et al.*, 1985). The student, who achieves great on this component, is experienced anxiety when registering in a statistics course, resolving statistical problems, or taking a statistical test. The test and class anxiety factor is obtained from the following questions: 1, 4, 8, 10, 13, 15, 21 and 22 (Cruise *et al.*, 1985).

The “computational self-concept” factor determines the respondent’s ability to perform operations. It reveals nervousness related to current mathematical calculations; so, relating to traditional mathematics anxiety. However, the student that achieves high on this component practices anxiety, because it involves mathematical computations and the student handles uncomfortably, feels inadequate, when understanding, dealing statistics. The computational self-concept factor is derived from questions: 25, 31, 34, 38, 39, 48 and 51 (Cruise *et al.,* 1985).

The “fear of asking for help” factor (from peer students or facilitators) involves the understanding of statistics material and statistical output, as well as interpreting statistical output for each respondent. A great total on this component discloses a terror of asking a colleague student, or the facilitator (professor), for help with statistics difficulties (Cruise *et al.,* 1985). The "fear of asking for help" component is obtained from questions: 3, 16, 19 and 23. The final factor, the fear of statistics teachers, consists of the respondent's anxiety of evaluating the professor's attitude, language and computational orientation. This component deals with the student's perception of the statistical monitor or professor (Cruise *et al.,* 1985). According to the researcher, high score on this particular component questions the "humanness" of the statistical monitor or professor. The student views the statistical monitor or professor, as lacking in the ability to consider him as a person (human being) (Cruise *et al,* 1985). The fear of statistics teacher factor arises from questions: 30, 32, 43, 44, and 46.

Socio-demographic attributes are main generators of social characters and uniqueness. These factors tend to produce individualities that are high in salience (Smith, 2007). The socio-demographic factors in this research study include age, gender, marital status and ethnic group of the respondent. Age is the interval of time between the day, month and year of birth, expressed as the number of years lived by an individual, which is a person's age at their last birthday (StatsSA, 2011). This variable determines the age of the respondent at the time of the survey (December 2015 – March 2016). The question asked was "What is your date of birth?" Those respondents, who were unable to remember their exact date of birth, were asked to give an approximate age in completed years. This variable was used to identify students, who were part of the postgraduate programme during the time of survey.

Postgraduate programmes tend to be selective, in terms of gender; however, previous studies have indicated that postgraduate students tend to be predominantly males (Hannigan *et al.*, 2014; Coetzee & Van der Merwe, 2010; Teman, 2013). Gender was used to identify male and female respondents. Knowing whether a person is male or female helps to identify sex differentials in their ability to learn statistics, as well as choose the right statistical procedures in their academic work (Halpern *et al.*, 2007). Gender clarifies which sex is more represented. Regarding gender, the respondent was asked to state his/her relevant gender by choosing male or female.

Marital status describes the civil status of each individual in relation to the marriage laws, or customs of the country (Budlender *et al.*, 2004). The question asked was, "What is your marital status?" The respondent had the option to choose the relative status (single, married, divorced, widowed and cohabiting). Therefore, this variable was used to observe the pattern of marital status among postgraduate students, in relation to the self-efficacy to learn statistics theory.

According to Cohen (1982), an ethnic group designates as a social category of individuals, who recognise with each other, based on common ancestral, cultural national or social experience. The respondent could choose one of the following options: "African, Coloured, Indian/Asian and White".

This section evaluates the respondent's previous knowledge in statistics and academic research. For all the relevant questions on this section, the respondent was asked to specify the appropriate digit that best describes his/her experience: 1= Very bad, 2= Bad, 3= Average, 4= Good and 5= Excellent. Previous knowledge in statistics implies the confidence in applying statistics procedures and its impact in the respondent's current study (Mertler & Reinhart, 2016). This factor is drawn from questions 3, 4 and 6. Knowledge in academic research represents a part of the experiences gained in learning research methodology of the respondent. This variable resulted from questions 1, 2 and 5.

Enabling factors are defined as factors that facilitate behaviour change in individuals or populations (Fullan, 2007; Straub, 2009). Enabler components comprise only academic factors, including academic institution, postgraduate programme, as well as the type of study and student nationality. The academic institution is an educational organisation, devoted to education and research, and which grants academic degrees (Altbach, 2004). For this variable, the respondent was requested to state his/her academic institution, from a choice of either UWC or UCT. The postgraduate programme includes knowledge and studying for degrees, professional or academic certificates, or other qualifications, for which a first or Bachelor's degree, generally, is required, and is normally considered to be part of higher education (Hill, 2007). For this variable, the respondent was asked to select the relevant programme, such as MA, PhD, or Post-doctorate.

The type of study refers to the respondent's enrolment type. Full-time means that students are expected to be available for classes during the full-time period, while part-time consists of employment outside of class time, weekends and in the evenings (Kuh, Kinzie, Schuh & Whitt, 2011). The respondent was asked to inform whether s/he had decided to take the full-time or the part-time route for their studies. Nationality is defined as membership of a particular nation or state, by origin, birth, naturalization, ownership, allegiance (Hofstede, 1983; Calhoun, 1993). In this current study, student status refers to students, who are sharing a common origin, culture and/or language, and possibly constituting a nation-state. For this factor, the respondent was asked to select one of the following: South African, African, or non-African.

4.6.6.2. Behaviour variables

These behaviour factors are presented as two components; attitudes toward the field (interest and effort), and attitudes toward the statistics course (affect, cognitive competence, value and difficulty). Both are relatively stable, resistant to change, and comprise a large cognitive component with less emotional intensity than emotions. Nine of the 28 items are positively worded; the remaining 19 items are negatively worded. Negatively worded items were reversed so that higher scores always indicated a more positive attitude (Wise, 1985).

According to McLeod (1992), the attitudes toward the field, represent affective responses that include negative or positive feelings of moderate intensity. Philipp (2007) describes attitudes towards statistics as a manner of acting, feeling or thinking that reveals a person's disposition, or opinion towards a topic. The component, attitudes towards the field, includes two sub-components, namely, interest and effort. In fact, the sub-component, interest (4 items), reveals the students' level of individual interest in learning statistics. Similarly, effort (4 items), describes the amount of work the student expends to learn statistics (Wise, 1985).

Chiesi and Primi (2009) define attitude towards statistics as a disposition to respond favourably or unfavourably to objects, situations or people related to statistics learning. Although some studies reveal a positive attitude towards statistics (Chiesi & Primi, 2009; Perepiczka *et al.*, 2011), Coetzee and Van der Merwe (2010) reveal evidence of unfavourable responses, to compensate for any favourable responses. In addition, the component, attitude towards the statistics course, comprises four sub-components, namely, affect, cognitive competence, value and difficulty (Wise, 1985). The sub-component, affect (6 items), assesses the students' positive and negative feelings about statistics, while cognitive competence (6 items) describes the students' intellectual knowledge and skills applied to statistics. The component, value (9 items), captures attitudes about the usefulness, relevance and worth of statistics, and difficulty (7 items) measures the students' opinions about the difficulty of statistics as a subject (Wise, 1985).

4.6.6.3. Social supports

Social support is defined as behaviour that assists students, who are undergoing stressful life circumstances, to handle the problems they face in learning statistics, effectively (Tam & Lim, 2009). Concerning the environment factors, this variable regroups multiple social supports, relating to the source, namely, social support from significant others (4 items), from friends (4 items) and from family members (4 items). These factors indicate how students feel about each statement. However, social support is a factor that appears to improve the students' ability, which may provide them with opportunities to develop an understanding, or ability to handle a task (Zimet *et al.*, 1988; Salazar, Oerlemans & Van Stroe-Biezen, 2013).

4.6.6.4. Self-efficacy learning

As mentioned in section 4.6.3, the self-efficacy to learn statistics (SELS) scale measures confidence in one's ability to learn statistics. However, an absolute difference, observed between the two scores of each component, indicates a closer fit between reality and the respondent's preference; therefore, a greater comparison exists between the "actual" and "preferred" confidence in an individual's ability to learn statistics. Fourteen (14) items are grouped into four components, namely, personal accomplishments or performance outcomes (4 items), vicarious learning experiences (2 items), Verbal persuasions (3 items) and emotional inspirations (3 items) (Franke, Keinz & Steger, 2009).

4.6.7. Data analysis procedures

Some comparisons were done for each component factor, as well as cross-sectional comparisons within the institutions. The findings of the analysis were presented in the form of graphs, tables and summarising reports. This section focuses on information gathered from the method of observation, comparing the observed with the expected findings, and multivariate analysis.

4.6.7.1. Descriptive analysis

For each variable, frequency (total scores), percentage, means, standard deviation, lowest and highest possible values, and some figures are presented. Given that each factor was summarised per component, the comparisons were done in each set of data, for both universities.

4.6.7.2. Multiple comparisons

Although there are many different statistical techniques available in the SPSS package, only three (3) main techniques were applied to compare the mean scores for the respondents and variables across universities. Independent samples t-tests were used for only two groups, the analysis of variance (ANOVA) techniques were used in three or more groups, and the chi-squared was used to cross-tab each variable across universities.

The observations that make up the data have to be independent of one another; therefore, each observation or measurement should not be influenced by any other observation. Violation of this assumption, according to Schau *et al.* (1995), is very serious. If Levene's test of homogeneity is greater than .05, the first line in the table of the independent samples t-test, which refers to equal variances, is assumed. In case Levene's test of homogeneity is less or equal to .05, the variances for the two groups are not the same; therefore, the data violate the assumption of equal variances. The second line of the t-test table, which refers to equal variances not assumed, must be used (Zimmerman, 2004; Garson, 2012). For the t-test, the procedure for calculating Eta squared (R^2), is as follows:

> R^2 (Eta squared) = $t^2 / [t^2 + (N_1 + N_2 - 2)]$ where t is the score of … from the t-test table, N_1 is the size of the first group, and N_2 the size of the second group.

It is assumed that the population, from which the samples were taken, were normally distributed, according to parametric techniques. The two data sets were assumed as Normal distribution. With a p-value of less than, or equal to .05, the null hypothesis is rejected, indicating that at least two of the three group populations' means were equal. Therefore, the differences in mean are caused by the induced variable, and among the three means, at least two of the means differ. Again, there is a need to look at which groups differ. For the one-way ANOVA, there were the deviations of individual scores from the overall mean of the data, into the deviations of the group means from the overall mean, and then the deviations of the individuals from their group means. Obviously, the tests of equal variances are based only on the values in this one experiment. R^2 (eta squared) is Effect Size or Size of Effect, and provides an indication of the magnitude of the differences between groups [not just whether the difference could have occurred by chance, or due to some external factors] (Field, 2009). It is calculated from the ANOVA table, equalling the sum-of-squares between groups, divided by the total sum-of-squares. The standards for interpreting this value are .01=small effect, .06=moderate effect, and .14=large effect (Cohen, 1988).

For the combined data of both universities, cross-sectional analysis was applied, which involved the observation of all the variables, at one specific point in time, or without regard to the differences in time. This method consists of comparing the differences observed across each instrument and for each variable (Frankfort-Nachmias & Nachmias, 2007). These include items, components and overall components or factors. The difference between the scores of items, reveal the level of improvements realized for every category of instrument (component). However, if the difference is negative, the quality of the score is relatively poor for that particular item, or component (Wilson, 2004). The change in the score structure, during the survey could be characterized by a gradual decline in relative outcome, for instance, of the young or older students' age (Considine & Zappalà, 2002; Lee & Burkam, 2003). The comparison indicates the differences in scores from data, broken down by background information (for example, gender, student status, marital status). Apart from differential under enumeration in various individual characteristics, the comparison helps to highlight whether the data suffers from distortion, due to social, cultural and legal habits, as well as norms observed in an academic environment in South Africa (Nkabinde, 1997; Ball, 2006). The change describes the variation between the current score and the previous score, at a point in time. If the value of the variation is positive, it indicates improvement; while, if the value of the variation is negative, it indicates that deterioration has occurred (Nkabinde, 1997).

4.6.7.3. Multivariate analysis

The ordinal regression method was used to model the relationship between different levels of self-efficacy to learn statistics, regarding the learning ability to apply statistics in academic research, and the explanatory variables, concerning demographics, emotion, behaviour and the students' learning environment at UCT and UWC. The major decisions involved in the model building for ordinal regression were, deciding on the explanatory variables to include in the model, and choosing the link function, for example, logit link, probit link, negative log-log link, complementary log-log link and Cauchit link, which demonstrated the model's appropriateness (McCullagh, 1980). In addition, the model fitting statistics, the accuracy of the classification results and the validity of the model assumptions, for example, parallel lines, were essentially assessed in order to select the best model (McCullagh, 1980; Goldstein, 2011).

The outcome variable for students' self-efficacy to learn statistics was measured on an ordered, categorical, six-point Likert scale, ranging from 'no confidence at all', to a 'little confidence', 'a fair amount of confidence', 'much confidence', 'very much confidence' and finally, 'complete confidence'. It is implausible to assume the normality and homogeneity of variance for ordered categorical outcomes (Elamir & Sadeq, 2010). The test of normality was not significant; therefore, the ordinal regression model becomes a preferable modelling tool that does not assume the normality and constant variance, but requires the assumption of parallel lines across all levels of the categorical outcome (Elamir & Sadeq, 2010).

Explanatory variables include seven demographic levels, namely, gender, age, ethnic group, marital status, postgraduate programme, student status and type of study; 6 items related to the level of experience in research methodology and statistics; 51 questionnaire items related to the statistical anxiety of STARS; 36 items of attitudes towards statistics; and 12 items of perceived social support.

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4.6.8. Limitations of the methodology

Regrettably, data limitations pressured the researcher to consider students of various racial, ethnic backgrounds and sexual orientations together, as if their experiences were similar. Studying the behaviour and performance of students, learning in pairs or small groups, the behaviour of each member of the group could influence the rest of the group members, thereby violating the assumption of independence (Lee, Huh & Reigeluth, 2015). In addition, all the respondents could be influenced by the presence of a limited number of individuals, who are at variance; therefore, the individual behavioural or performance measurements, are not autonomous.

4.7. Qualitative Research Design

4.7.1. Sample of participants

Sampling refers to the process of selecting a segment of the population to represent the entire population (Creswell, 2013). All MA and PhD/post-doctorate students, enrolled in postgraduate programmes, were eligible to participate in this research project. The selection method was purposive sampling, as the participants were available to provide easy access to special perspectives, as well as experiences that could facilitate a better understanding of the phenomenon under study. The samples for this qualitative phase were selected from the respondents, who were involved in the quantitative phase of this current study. The researcher met the prospective participants individually, and requested their voluntary participation in the qualitative phase interviews. Consequently, 19 students were purposively selected from different departments at both institutions, effectively, 12 students, who were enrolled at UCT and seven at UWC. Regrettably, four students (two at each institution) withdrew from the study during the interview sessions. The researcher conducted one-to-one, semi-structured interviews, prepared in advance, with each participant. The responses were transcribed and reported in categories or themes. Data was saturated when the researcher could no longer gather any new information, or extract any new categories, or new inputs into new categories, from the data (Babbie, 2010). Therefore, a few UCT and UWC participants were selected from their sub-groups, to study in-depth, as well as explore, as much as possible, their personal perspectives, experiences and understandings of the application of statistical procedures in their academic work (Gelo *et al.*, 2008).

4.7.2. Data Collection

The qualitative method combines a predetermined set of open-ended questions, as well as detailed questions, formulated ahead of time. The semi-structured interview starts out with more general questions, followed by prepared questions, and ends with questions that emerged during the interviews (Rowley, 2012; Creswell, 2014). The effectiveness of semi-structured interviews depends on the communication skills of the interviewer (Clough & Nutbrown, 2007). Cohen, Manion and Morrison (2007) emphasize that these skills include the ability to clearly structure questions, listen attentively, prompt appropriately, and encourage the interviewees to respond. Interpersonal skills help to establish humour, humility, relations and trust, expected to be present between the participants (Cohen *et al.*, 2007).

In this current study, the researcher arranged individual meetings for the 19 participants in safe, suitable, comfortable venues. Initially, the researcher made introductory small talk and revisited all the ethical considerations, before handing the participant the qualitative questionnaire of tasks (statistical test items) to complete. While the participant completed the questionnaire, no discussion took place. Unfortunately, four participants dropped out during the interviews, as they found the tasks (statistical test items) beyond their ability and knowledge to accomplish. After the questionnaire of tasks were completed, the researcher asked several analytical questions, such as “How did you decide?”; “Which information in the item notified or oriented you to that choice?”; “What will the test tell you?” Ultimately, the data were captured in one file, for each university (qualitative data).

4.7.3. Description of the Qualitative Data

The participants for the qualitative phase of this current study were already well informed about this research project, as they were involved in the quantitative phase, as well. The researcher agreed with them to meet during their break period, so as not to interrupt their academic programme. Participation in this phase of the research was voluntary, no incentives were offered, and there was no penalty for not participating or withdrawing during the interviews. In addition, for this qualitative phase, the same ethical considerations were adhered to, as per the quantitative phase.

The researcher deviated from the norm of interviews by preparing a questionnaire, with tasks and statistical test items, for the participants to complete/perform/select (Appendix 7). The participants completed the questionnaire/tasks in 3 hours. The researcher evaluated their behaviours, following their choice of statistical tests, applied in the different items of the questionnaire. Thereafter, the participants responded to detailed questions regarding the questionnaire/tasks, which lasted approximately 10 to 12 minutes. All records were transcribed and monitored for UCT and UWC, respectively. (For detailed description, see Chapters 5 and 6).

4.7.4. Ethical Considerations

Qualitative research plays a key role in coming up with a different perspective on the same social phenomena (Creswell, 2014). The researcher ensured that, as with the quantitative phase, all ethical requirements (informed consent, anonymity, privacy) were maintained for the qualitative phase. As mentioned earlier in the quantitative phase, the authorisation to conduct the research was acquired from the selected academic institutions. Information letters (Appendix 4) regarding the study were again relayed to the participants, via email. In addition, separate information letters (Appendix 5), regarding the purpose of the study, were distributed to the lecturers, staff members of related departments, peer students and all the participants. Informed consent was obtained, by disseminating individual consent forms to the participants, lecturers, staff members and peer students. All forms were administered in English, since it is the main language of instruction at universities in South Africa. The researcher again ensured that the participants were well knowledgeable around the drive of the second phase of the research, the benefits to the participants, the extent of privacy, confidentiality and the freedom to remove or withdraw from participation, at any phase and time (Silverman, 2010).

Robson (2011) defines rigour as the way of establishing the credibility and integrity of the qualitative research process. Rigour was improved by paying consideration attention to the credibility and trustworthiness in the study. The researcher ensured the credibility of the study by listening intently during the interviews, in order to gather new information on the topic under discussion. After data collection, the descriptions of the perceptions and attitudes of the participants' views, from all the interviews, were presented in verbatim transcriptions (Yilmaz, 2013). When the interviews were completed, the researcher rechecked the interpretation and transcribed data with the participants, to validate their responses and identify themes. Clarifications needed to comprise the succeeding issues: the nature of the study, the participants' potential role, the objective of the research, as well as how the results should be used (Onwuegbuzie *et al.*, 2012). In addition, the researcher needed to clarify that the research findings would benefit science, and contribute to the development of education policy.

In this current study, trustworthiness was achieved by clarifying the links between the results and the data collected, with the aim of identifying factors leading to more effective learning statistics documentation (Elo *et al.*, 2014). All personal information obtained from the study were kept confidential, by ensuring that only the researcher and the supervisors had access to such information (Adler & Lerman, 2003). All the qualitative questionnaires (Appendix 7) containing the responses of the participants were stored securely. The gathered data were electronically stored in a password-protected file, and unauthorised access to these records was not allowed.

4.7.5. Data Analysis

This current research commenced with the premise that the implementation of learning statistics policies, in the selected academic institutions, had failed. The study was aimed at analysing the reasons for this failure, as well as introducing reforms in the statistics learning process. Before engaging with this task, it became necessary to search for a theoretical framework that could guide the investigation, analysis and interpretation of the findings (Creswell, 2014). This was decided by the following questions: "What are the differences in the misconceptions of how to select a statistics test?" "What constitutes the failure of the learning statistics?” “How is this research conducted?” as well as “How is the relationship between students’ SELS beliefs and their independent factors, determined?” Therefore, the Explorative design was selected as a theoretical framework to guide the investigation, analysis and interpretation of the findings. Explorative design is divided into two modules, namely, the descriptive research approach, which examines distributions and relationships among different distributions, and the interpretive or explanatory approach. Interpretations move beyond the explicit descriptions provided by the individual participants, drawing on the researchers’ interpretation, and evidently, interpretations that were more abstract, were related to the data provided by the study participants (Ormston, Spencer, Barnard & Snape, 2003).

4.7.5.1. Descriptive research and relationships

Postgraduate programmes in the academic environment offer complete assistance that endorse learning. These programmes offer structure, information, activities (workshops, conferences), practice, as well as feedback, and are organised in such a manner that postgraduate students can study, even if they do not have the benefit of a mentor or classmates (peers students). In addition, the development team comprises postgraduate students, faculty content experts, human-computer interaction experts, and statistics monitors, which enable this framework to utilise the best multidisciplinary knowledge to design effective learning (Naidu, 2003). Garfield and Ahlgren (1988) highlight the need for collaborative research on how students accurately comprehend probability and statistics. This current study aims to examine the empirical results that characterize different circumstances of choosing the right statistical test, to explain and predict observed data.

Therefore, principles and practices, to describe the variation in learning statistics among postgraduate students, should be developed. A reasonable length of the narrative, allows good coverage of many of the issues. In addition, the researcher should write succinctly, ensure that the narrative reads well, should not become bogged down in any one issue, and communicate meticulously, the range of skills, needed in learning statistics (Creswell & Clark, 2007).

4.7.5.2. Interpretive approach

The explanation assessment tool considers the views of postgraduate students in the analysis of their knowledge about using statistics skills to choose the right statistics test. It appears that the increase of participation during seminars, presentations, as well as the writing-up of theses by postgraduate students confirms the declaration of various authors that postgraduate students are the only experts on their life experiences and priorities (Petre & Rugg, 2010; Lee, 2011). In addition, the explanation assessment tool is usually open-ended questions, and interactive in design; therefore, they facilitate the exploration of issues, as well as shared learning between postgraduate students at different universities (Laurillard, 2013). Consequently, it appears that participation in seminars/presentations, empowers weaker students to define learning on their own terms, based on their perceptions and understanding of the phenomenon (Earl, 2012).

Obviously, when faced with the question of how students chose the right statistical procedures, it is not easy to understand human attitudes and behaviours, unless the relevant meanings are understood (Skinner, 1953; Schank & Abelson, 2013). These attitudes or behaviours include, reason, intentions, beliefs or emotions. The students explain connotations in diverse ways, using logical progression, the characteristics of individuals, as well as the structural links between concepts and knowledge or performance (Keller, 2009). Students act on their beliefs and preferences; however, many scholars protest that such clarifications absence the power of general applicability, as beliefs and preferences are impossible to corroborate (Bevir & Rhodes, 2002). For example, researchers pursue to avoid beliefs, by relating statistical procedures with objective evidences, to build the rationality of student attitudes; however, rational students tend to raise interest when performance increases (Scott & Davis, 2015). The interpretive approach cannot separate student opinions and inclinations from objective evidences, such as the socio-characteristics, including ethnic group, post-graduate programme, gender, marital status, student status, and type of study. This impossibility of pure experiences implies that they cannot reduce beliefs, interests, expectations, motivations and partialities to mere overriding variables (Ormston, Spencer, Barnard & Snape, 2014).

The various interpretive approaches are subjective, rationality and relativism (Bernstein, 2011). However, a true and full understanding of another student's thoughts is possible only when its affective aspect is understood (Laurillard, 2013). To set the tone on the core of this matter, observations made by post-graduate students are insightful, and supply valuable material for stimulating reflections on learning (Kerr, 2005). The close relationships with their fellow students enable them to have more access to their thoughts and feelings, than is usually possible for someone learning statistics at University (Brophy, 2013). The exploration of the students' ability facilitates the understanding of difficulties that emerge during their learning process (Meyer & Land, 2013). In support of this view, Lee (2011) proposes that an important function of this methodology is the empowerment of the supervisors with the primacy of natural knowledge being asserted over externally determined measurement criteria. This technique emphasizes the ability of weak postgraduate students to understand and analyse their own reality, while the supervisors define or determine criteria for identifying the slow, or inefficient, student usually during presentations, seminars and the final write-up.

The interpretive approach attempts to measure (understand) the self-efficacy learning in individual characteristics, behaviours, as well as the social environment of a specific university (Shea & Bidjerano, 2010). Consequently, this assessment identifies weak students based on a supervisor's own criteria (definition and perceptions of self-efficacy learning). Deane, Samuels & Williams (2009) acknowledge that the application of statistical procedures needs to be addressed in the formulation of strategies, which aim to improve self-efficacy learning statistics, in university policy. Chen (2007), Meyer (2009) and Hassen (2013) claim that, based on their experiences, postgraduate students display multiple dimensions of positive/negative anxiety and attitudes, as the values and priorities of these weak postgraduate students. Some students argue that self-efficacy in learning statistics is not extremely effective in assessing the application of statistical procedures in academic research (Rust, O'Donovan & Price, 2005; Colthart *et al.*, 2008). Shute (2008), Papastergiou (2010), as well as Biggs and Tang (2011) mention that the ability of postgraduate students to acquire self-efficacy is easy, compared with solving and learning tasks, while it was generally well accepted by the target population.

This analysis encounters diverse perceptions that sometimes adhere, and other times diverge; therefore, the objective is to leave space for additional negotiation and rational on these issues. However, the intention is not to reach conclusion, and settle any of the issues, but to open up threads for on-going discussions (Luitel & Taylor, 2007).

4.7.6. Qualitative Limitations

A qualitative approach that examines and interprets data could limit the potential of the findings, due to its subjective nature (Polit & Hungler, 2006). However, it is argued that, as an interpretation technique is useful at university level or in specific environments only, it is not suitable to assess learning statistics across departments, faculties and universities levels, for the purposes of comparisons (Biggs, 2011). The reasons for the shortcomings are due to the fact that it is difficult to verify the results of interpretive assessments, as they arise from the subjective ratings of supervisors (Black & Wiliam, 1998). This approach, therefore, creates a challenge for the collection and analysis of a proposed large sample size.

4.8. Reliability and Validity

Reliability relates to an instrument as a whole, and whether measurements are being made. Without reliability, findings and recommendations are meaningless and misleading (Pallant, 2013). However, consistency may be crucial for the trivial, but misleading for the insightful (Falchikov, 2013; Yilmaz, 2013). The reliability and recommendations are related to the interpretation of scores from instruments (scales) used in the study (Streiner & Norman, 2008).

An instrument is valid if it measures what it has been intended to measure; therefore, it considers the substance of the measurement (Sireci, 1998; Streiner, 2013). In quantitative research, validity is addressed through the honesty, depth, richness of the data, as well the scope to be achieved, and depends on the clarity of the research study's details and aims (Tracy, 2010). Effective sampling, appropriate instrumentation, as well as statistical assessment methods, will ensure that the instruments measure what they are intended to measure (Onwuegbuzie *et al.*, 2007). Widely accepted research methods are adopted to ensure validity, such as, recording all of the processes followed during the research (Yin, 2006), and providing for participant validation (Neuman, 2006).

Various types of validity are identified, namely, face, content, external, internal, predictive, as well as construct validity (Sireci, 1998). Construct validity is the degree to which a score can be interpreted as representing the content, internal structure and relation to other variables that the instrument items construct (Cook & Beckman, 2006). Regarding the STARS, SELS, SATS and MSPSS, a total score is determined from each instrument, while the internal consistency reliability (Test of Cronbach's Alpha) is determined to ensure the internal validity of the instrument (Streiner, 2013). In addition, an instrument is perceived as reliable, when it can be used by a number of different researchers, under stable conditions, with consistent results (Bless, Higson-Smith & Kagee, 2006; Streiner, 2013).

4.9. Synthesis and Partial Conclusion

In this chapter, the methodology followed in this current research study was presented, including the data gathered, analytical methods and procedures of analysis. Three data sets were gathered in the quantitative phase, including the UCT data, the UWC data and the combined data of both universities. In addition, the context in which the study is situated was presented. The UCT data were collected from the postgraduate students on the UCT campuses, while the UWC data were gathered from postgraduate students on the UWC campus. The target population of this current study comprised three population groups: MA, PhD and post-doctorate students.

Quantitative and qualitative analysis were applied. The quantitative analysis comprised two stages, descriptive and multivariate analyses. At the descriptive level of analysis, a "Chi-squared test", an "independent samples test" and a "one-way ANOVA test" were used. At multivariate level of analysis, several ordinal regression models were performed at UCT, UWC, and for combined data, at both universities. The analyses were done using the SPSS version 24 software. The study focussed on the assessment of SELS beliefs level provided by the data. The assessment of the method, which was developed to adjust the observe information, the comparison of each variable, the comparison of the findings across universities, as well as the determination of the best model for each university, and across universities, was made.

The qualitative examination was also applied in this current study. Two data sets were used, namely, the UCT data and the UWC data. A few participants from UCT and UWC were purposively selected to conduct an in-depth study on how to choose a correct statistics test. Authorisation to lead this research study was received from both universities. The participants were MA, PhD and post-doctorate students. A semi-structured interview and spontaneity questions enabled the researcher to collect rich data. Each interview lasted three hours and 10 to 12 minutes. The responses/data were transcribed and reported in categories or themes. The qualitative analysis comprised two stages, namely, the descriptive and interpretive approaches. In this current study, the researcher aimed to examine the empirical results that characterized different situations for choosing the correct statistical test, and explains, as well as predicts observed data. Regarding the interpretive approach, an understanding of the phenomenon generated ideas and theories. The explanation of connotations in different methods, using logical development and the characters of students, clarified the operational links between perceptions and knowledge or performance.

CHAPTER FIVE

FINDINGS: THE CASE OF UCT

5.1. Introduction

In this chapter, the researcher outlines the overall results, regarding the analyses of self-efficacy to learn statistics (SELS) beliefs among postgraduate students in the UCT environment, presented in two parts, the quantitative data analysis, and the qualitative data analysis. The quantitative findings revealed that the experiences, STARS and effort components were significantly different in means scores of SELS beliefs, and the ordinal regression model, using the logit link function, was the best model, with a high prediction accuracy of 73% for all three categories combined. The qualitative findings, founded on the comments of the participants, emphasised a deep understanding of the perceived failures in selecting suitable statistical tests. These results reveal that confusion and frustration characterised the students' attitudes.

5.2. Quantitative findings

The analysis was based on four main steps, the descriptive analysis, validity and reliability of the instruments, impact of independent variables on the self-efficacy to learn statistics, and the multivariate analysis. All these steps were conducted on the UCT data. The results were presented separately. Each result focused on particular risk factors of self-efficacy to learn statistics.

5.2.1. Descriptive analysis

The results of the analysis are summarised in the form of tables, graphical representations and narratives. This section comprises the characteristics of the respondents, enrolled in the postgraduate programmes, using background information (gender, age of respondent, marital status, ethnic groups, postgraduate programmes, student status, academic institutions, type of study and department), experiences (experience in research methodology and in statistics), emotion, behaviour, social support and the ability to learn statistics, obtained from the survey questionnaire. The quantitative responses were evaluated using percentages, means and standard deviations, obtained through frequency tables.

5.2.1.1. Background information of respondents

Table 5.1 illustrates the respondents' characteristics including gender, age of respondent, marital status, ethnic groups, postgraduate programmes, student status, academic institutions, type of study and department. In addition, Table 5.1 illustrates that 151 graduate students completed the background information.

Table 5.1: Characteristics of respondents (UCT)

Characteristics	N	%	Characteristics	N	%
Gender			***Marital status***		
Male	116	76.8	Single	105	70.0
Female	35	23.2	Married	32	21.3
Total	151	100.0	Divorced	2	1.3
Age group			Widow	1	.7
20-25	33	21.9	Living together	10	6.7
26-30	65	43.0	Total	150	100.0
31-40	45	29.8			
41 and +	8	5.3	***Student status***		
Total	151	100.0	South African	73	49.0
Ethnic groups			African	60	40.3
African	74	49.0	Non-African	16	10.7
Coloured	14	9.3	Total	149	100.0
Indian	14	9.3			
White	49	32.4	***Post-graduate programme***		
Total	151	100.0	Master	93	62.8
Type of study			PhD	48	32.4
Full time	141	94.0	Post-doctorate	7	4.7
Part time	9	6.0	Total	148	100.0
Total	150	100.0			

Source: Own computation using UCT data

5.2.1.1.1. Gender

The respondents were male dominated. Figure 5.1 illustrates that there were more males (76.8%) compared to females (23.2%).

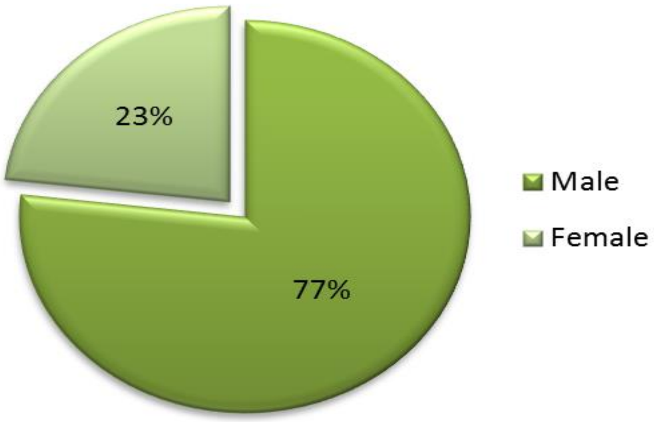


Figure 5.1: Percentage distribution of gender
(Source: Own computation using UCT data)

5.2.1.1.2. Age groups

One-hundred and fifty one (151) respondents completed the age information on their questionnaire forms. The ages were categorized into four groups: the youngest age group (20-25) represented 21.9%, followed by the dominated age group (26-30) at 43%, the age group (31-40) at 29.8%, and the over-40 age group at 5.3% (See Figure 5.2).

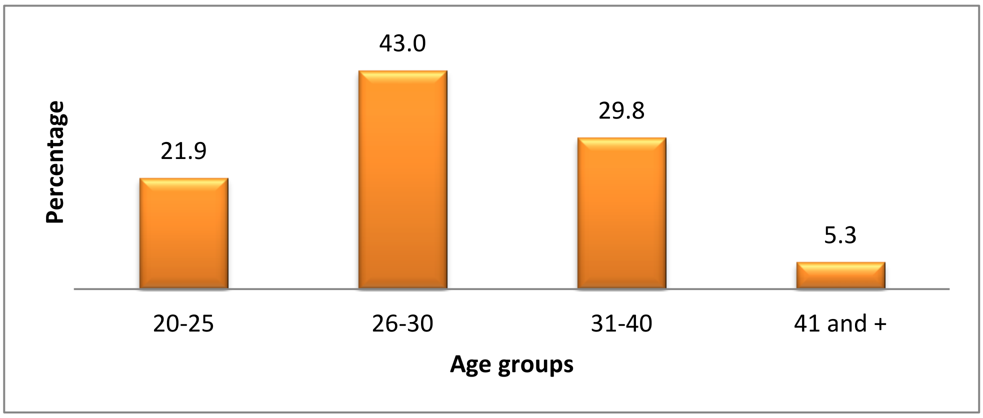


Figure 5.2: Percentage distribution of age groups of the respondents
(Source: Own computation using UCT data)

5.2.1.1.3. Marital status

Regarding marital status, the respondents were grouped into five categories, namely: single, married, divorced, widowed and co-habiting with partners. Figure 5.3 illustrates that single respondents scored the highest at 70%, followed by married respondents at 21.3%, while the smallest category was widowed respondents at .7%.

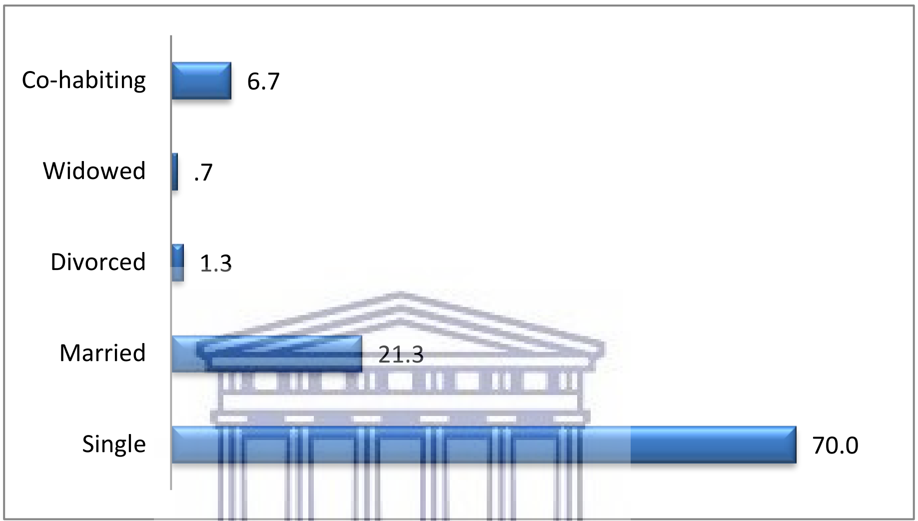


Figure 5.3: Percentage distribution of marital status of the respondents

(Source: Own computation using UCT data)

5.2.1.1.4. Ethnic groups

Figure 5.4 illustrates the ethnic groups of the respondents in percentages. Close to the half of the students (49%) were of a Black ethnic group. Indian and Coloured ethnic groups displayed the same percentage (9.3%), while the White group displayed 32.4%. It was of utmost importance to discuss ethnic groups in this study, as it was expected that this variable would affect the student self-efficacy to learn statistics.

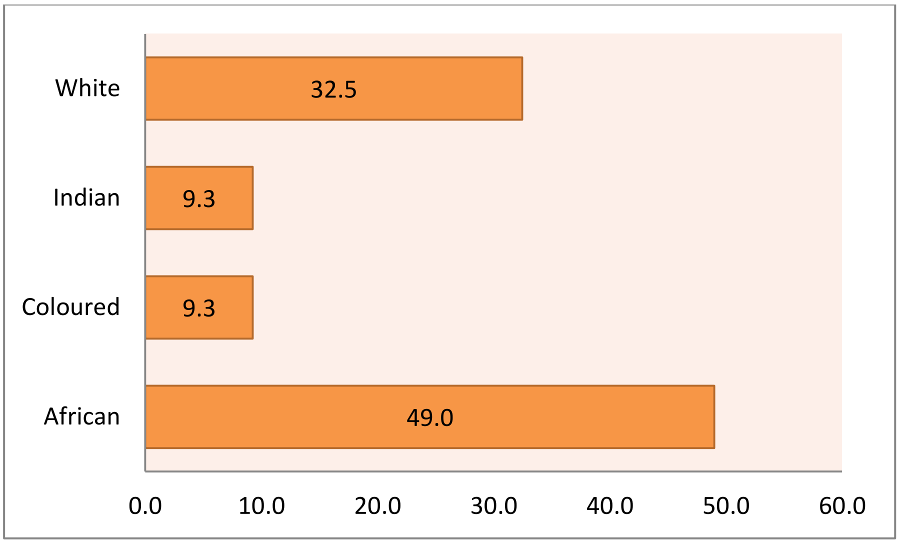


Figure 5.4: Percentage distribution of ethnic groups of the respondents
Source: Own computation using UCT data

5.2.1.1.5. Postgraduate programmes

The graph displayed in Figure 5.5 illustrates the progression of post doctorate, doctorate and master's degree output. The percentage of post-doctorate is infinitesimal compared to the rate of both MA and PhD graduates. The huge gap illustrated in the figure need to be reduced through effective funding of students at all postgraduate levels, and the progress reports of graduate students need to be monitored. However, MA students represent the highest score at 62.8%.

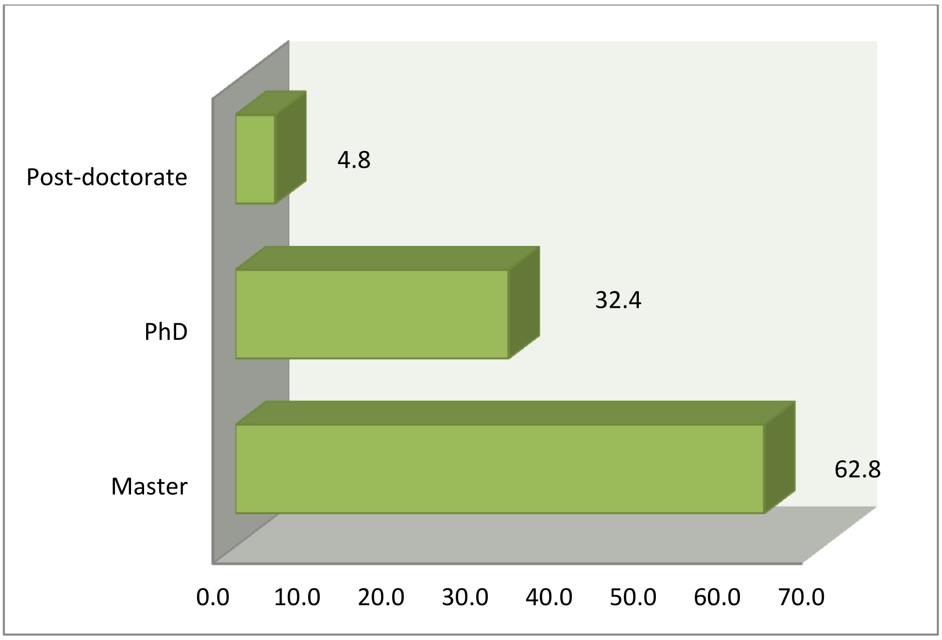


Figure 5.5: Percentage distribution of Postgraduate programmes

Source: Own computation using UCT data

5.2.1.1.6. Student status

Regarding student status, Figure 5.6 illustrates the distribution of graduates arranged in systematic order. Non-African comprises the smallest score (11%), while South African comprises the highest (49%), followed by other African countries (40%). The purpose of this chart was to gauge the surface layer of Pie with reasonable accuracy. However, African and South African are represented the most at 89%, which confirms the relevant improvement achieved in higher education.

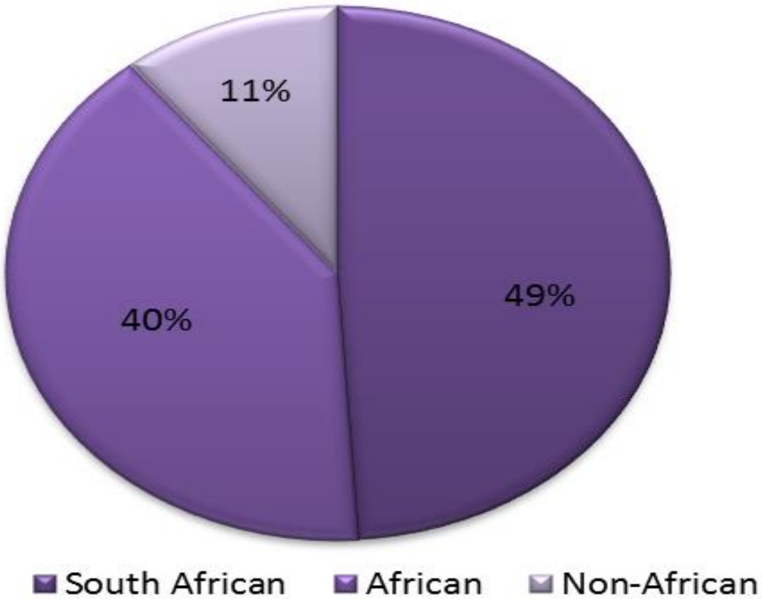


Figure 5.6: Percentage distribution of student status of the respondents
Source: Own computation using UCT data

5.2.1.1.7. Type of study

In Figure 5.7, the type of study for postgraduate students is illustrated as subdivided into two groups. The graph depicts part-time students as a very small percentage (6%) compared to full-time students (94%). Effort has been made to support those, who are working to improve their knowledge, by offering them the opportunity to further their academic objectives. However, full-time students were represented the most at 96%.

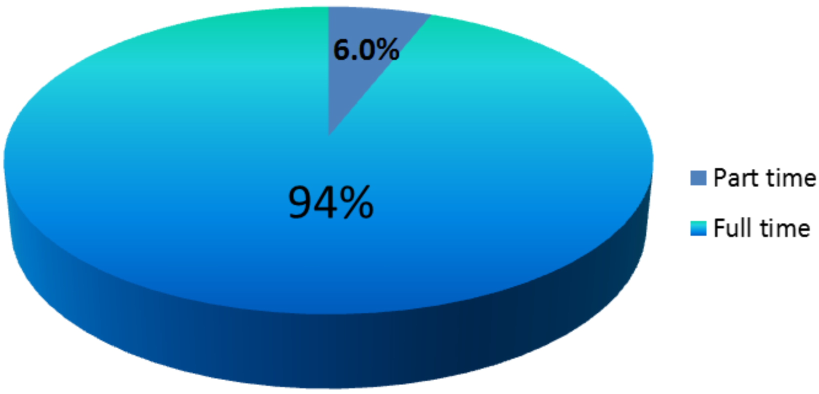


Figure 5.7: Percentage distribution of type of study
Source: Own computation using UCT data

5.2.1.2. Experiences

The total scores for the experiences of students are not homogeneous, as they differ in research methodology and statistics. Therefore, this section comprises a descriptive analysis of postgraduate students at UCT, based on the survey data. Table 5.2 illustrates the frequencies and the percentages observed, their mean scores and standard deviations for each experience component. In addition, 'Good' is illustrated as the highest category (62.3%) for students' scores in research methodology, followed by "Average" (23.8%).

Table 5.2: Distribution of student's experiences

Items	Very bad n (%)	Bad n (%)	Average n (%)	Good n (%)	Excellent n (%)	Total	Mean	SD
Exp. RM	0	3(2.0)	36(23.8)	94(62.3)	18(11.9)	151	2.7	0.5
Exp. Stats	1(.7)	9(6.0)	60(39.7)	66(43.7)	15(9.9)	151	3.6	0.7
Experiences	0	2(1.3)	47(31.1)	87(57.6)	15(9.9)	151	2.7	0.5

Source: Own computation using UCT data

Regarding experiences gained in statistics, less than 1% of the students scored "Very Bad", while 43.7% achieved the "Good" level. The same trend was observed for the *overall* experience. The mean score achieved in experience statistics was higher (3.6%), compared to those realised in both research methodology, and the *overall* experience (2.7%). Postgraduate students are more reliable in experience statistics, than in research methodology.

5.2.1.3. STARS

Regarding STARS, the results in the Table 5.3 illustrates that half of the respondents (50.3%) reported low anxiety in *"Test and Class"* anxiety, whereas only 16.5% displayed high anxiety. In addition, the majority of the respondents (68.9%) indicated low anxiety in *"Interpretation anxiety"*, whereas only 4.0% displayed high anxiety. Similarly, 67.6% of the respondents displayed low anxiety in *"Ask for help"*, as opposed to 6.6% of the respondents displaying high anxiety.

Table 5.3: Distribution of students' STARS

Components	No anx.	Low anx.	Mod. Anx	High anx.	Very high	Total	Mean	SD
Test and class anxiety	20(13.2)	56(37.1)	50(33.1)	21(13.9)	4(2.6)	151	2.56	.977
Interpretation anxiety	34(22.5)	70(46.4)	41(27.2)	6(4)	0	151	2.13	.803
Ask for help anxiety	41(27.2)	61(40.4)	39(25.8)	10(6.6)	0	151	2.12	.886
Worth of stats anxiety	52(34.4)	77(51)	19(12.6)	3(2)	0	151	1.82	.722
Fear of stats monitors	58(38.4)	68(45)	19(12.6)	6(4)	0	151	1.82	.801
Computational self-concept.	72(47.7)	56(37.1)	21(13.9)	2(1.3)	0	151	1.69	.759
STARS	26(17.2)	99(65.6)	24(15.9)	2(1.3)	0	151	2.01	.622

Source: Own computation using UCT data

Additionally, Table 5.2 illustrates that a substantial number of respondents displayed low anxiety in *"Worth of statistics"* (85.4%), *"Fear of statistics"* monitors (83.4%) and *"Computational self-concept"* (84.8%), while very few displayed high anxiety (2%, 4% and 1.3%, respectively). Concerning the *overall* score of STARS, the findings highlight that 82.8% of the respondents presented low anxiety, against only 1.3% with high anxiety. Regarding the mean scores, *"Test and class"* anxiety was the highest (2.56), and the lowest (<2 or less than 2) was recorded in *"Worth of statistics"* anxiety, *"Fear of statistics"* monitors and *"Computational self-concept"*. Therefore, it appears that on an average score, the students are moderate in *"Test and class"* anxiety, while they remain low in the other components of STARS.

5.2.1.4. SATS

Regarding the SATS scores, the results in Table 5.4 illustrate that more than two-fifths of the students (45.1%) displayed a low positive attitude in *"affect"*, compared to nearly one-fifth (20.5%), who displayed a high positive attitude. Similarly, 43.8% of the respondents displayed a low positive attitude in *"cognitive competence"*, as opposed to 15.6% with a high positive attitude. The majority of respondents (64.9%) displayed a low positive attitude in *"value"*, compared to 8.6%, who recorded a high positive attitude. Table 5.3 also illustrates that a substantial percentage of respondents displayed a high positive attitude in *"difficulty"* (33.2%), *"interest"* (80.2%) and *"effort"* (70.9%), while few displayed a low positive attitude (20.6%, 7.3% and 9.2%, respectively). The *overall* SATS score indicates that 25.1% of students reported a high positive attitude, whereas 12.5% scored a low positive attitude. Meanwhile, the mean scores revealed that *"interest"* and *"effort"* displayed the highest mean scores (5.1 and 5.2, respectively), and the lowest (3.4) was attained in *"Value"*.

Table 5.4: Distribution of student's SATS

Components	Lowest n (%)	Lower n (%)	Low n (%)	Moderate n %)	High n (%)	Higher n (%)	Highest n (%)	Total	Mean	SD
Affect	1(.7)	9(6)	58(38.4)	52(34.4)	23(15.2)	8(5.3)	0	151	3.7	0.9
Cognitive	1(.7)	6(4)	59(39.1)	60(39.7)	22(14.6)	2(1.3)	1(.7)	151	3.6	0.8
Value	1(.,7)	13(8.6)	84(55.6)	40(26.5)	10(6.6)	3(2)	0	151	3.4	0.8
Difficulty	0	9(6)	22(14.6)	70(46.4)	41(27.2)	8(5.3)	1(.7)	151	4.1	0.9
Interest	3(2)	1(.7)	7(4.6)	19(12.6)	56(37.1)	43(28.5)	22(14.6)	151	5.2	1.2
Effort	5(3.3)	2(1.3)	7(4.6)	30(19.9)	38(25.2)	43(28.5)	26(17.2)	151	5.1	1.4
SATS	0	4(2.6)	15(9.9)	94(62.3)	36(23.8)	2(1.3)	0	151	4.2	0.7

Source: Own computation using UCT data

5.2.1.5. Social Support

Social support in research and statistics situations is the perception that one is cared for, or has access to assistance (Yusoff, 2012). Table 5.5 illustrates that support from *"significant others"* presents as the lowest score of "strongly disagree" ([2], 1.3%), followed by "very strongly disagree" ([3], 2%), while the highest score emerges from "strongly agree" ([44], 29.1%), followed by "very strongly agree" ([38], 25.2%). Support from *"family members"* showed a similar trend; the smallest score was observed in "strongly disagree" ([1], .7%), followed by "very strongly disagree" ([4], 2.6%), while the highest score was achieved in the category "strongly agree" ([48], 31.8%), followed by "very strongly agree" ([44], 29.1%). The component support from *"friends"* presented a different structure with the highest score in category "mildy agree" ([44], 29.1%), followed by "very strongly agree" ([40], 26.5%), while the lowest score was achieved in "strongly disagree" ([2], 1.3%), followed by "very strongly disagree" ([3], 2%).

Regarding the *overall* social support, the respondents achieved the highest score in the category "strongly agree" ([53], 35.1%), followed by "mildly agree" (n=40, 26.5%), while the lowest score was achieved in "strongly disagree" ([1], .7%), followed by "very strongly disagree" ([3], 2%). However, the highest average score of the respondents was achieved in support from *"family members"*, while the lowest score was observed in support from *"significant others"*.

Table 5.5: Distribution of student's Social support

Component	VSD	SDe	MD	N	MA	SA	VSA	Total	Mean	SD
S. Others	3(2)	2(1.3)	6(4)	25(16.6)	33(21.9)	44(29.1)	38(25.2)	151	5.3	1.4
Family	4(2.6)	1(.7)	3(2)	26(17.2)	25(16.6)	48(31.8)	44(29.1)	151	5.5	1.4
Friends	3(2)	2(1.3)	2(1.3)	21(13.9)	44(29.1)	39(25.8)	40(26.5)	151	5.4	1.3
Social S.	3(2)	1(.7)	2(1.3)	23(15.2)	40(26.5)	53(35.1)	29(19.2)	151	5.4	1.2

Option	Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very strongly Agree
Abbreviation	VSD	SDe	MD	N	MA	SA	VSA

Source: Own computation using UCT data

5.2.1.6. Self-efficacy

Self-efficacy evaluates students' confidence regarding succeeding at a given task. Students were given two sub-sections on the evaluation of self-efficacy to complete; one to solve and the other to learn. The difference between the two instruments provides the aptitude to learn statistics or the self-efficacy to learn statistics (SELS beliefs).

5.2.1.6.1. Self-efficacy to solve

Regarding current self-efficacy (SELS) to solve and its components, Table 5.6 illustrates that for *"performance outcomes"*, *"emotional arousal"* and the *overall* component of SELS, the highest score was achieved in the category "much confidence" ([43], 28.5%), ([5], 34.4%) and ([51], 33.8%), respectively, followed by "very much confident" ([34], 22.5%), ([42], 27.8%) and ([47], 31.1%), correspondingly, while the lowest category was "no confident at all" ([8], 5.3%). Regarding *"vicarious experiences"* and *"verbal persuasions"*, the lowest score was observed in the category "no confident at all" ([5], 3.3%) and ([4], 2.6%), while the highest score was realised in the category "very much confident" ([52], 34.4%) and ([47], 31.1%), correspondingly. In addition, the mean scores indicated that the highest was observed in *"vicarious experiences"* (4.5), while the lowest was observed in *"performance outcomes"* and *"emotional arousal"* (3.9). Except for *"vicarious experiences"*, for which the mean score emerges in the "very much confidence" category, the mean scores of the other components emerge in the "much confidence" category.

Table 5.6: Distribution self-efficacy to solve

Component	NCA	LC	FC	MC	VMC	CC	Total	Mean	SD
Perform.	8(5.3)	19(12.6)	27(17.9)	43(28.5)	34(22.5)	20(13.2)	151	3.9	1.4
Vicarious	5(3.3)	4(2.6)	19(12.6)	42(27.8)	52(34.4)	29(19.2)	151	4.5	1.2
Verbal p.	4(2.6)	11(7.3)	16(10.6)	40(26.5)	47(31.1)	33(21.9)	151	4.4	1.3
Emotional	7(4.6)	18(11.9)	22(14.6)	52(34.4)	42(27.8)	10(6.6)	151	3.9	1.3
SELF-L	4(2.6)	10(6.6)	24(15.9)	51(33.8)	47(31.1)	15(9.9)	151	4.1	1.2

Option	No confidence at all	a little confidence	A fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using UCT data

5.2.1.6.2. Self-efficacy to learn

In this section, *"emotional arousal"* and the *overall* SELS to learn scored the highest in the same category "very much confident" ([54], 35.8%) and ([51], 33.8%) respectively, while the lowest scores were displayed in "not confident at all" ([4], 2.6%) and ([2], 1.3%), correspondingly. *"Performance outcomes"*, *"vicarious experiences"* and *"verbal persuasion"* displayed the highest scores in the category "complete confidence" ([53], 35.1%), ([54], 35.8%) and ([57], 37.7%), correspondingly, while the lowest scores were observed for *"performance outcomes"* in the category "no confidence at all" ([3], 2.0%), for *"vicarious experiences"* in the category "little confidence" ([1], .7%), and for *"verbal persuasion"* in both categories "not confidence at all", as well as "little confidence" ([2], 1.3%). However, the mean scores revealed that for all the components and the *overall* SELS were in the same category very much confident (5).

Table 5.7: Distribution self-efficacy to learn

Component	NCA	LC	FC	MC	VMC	CC	Total	Mean	SD
Performance	3(2)	5(3.3)	11(7.3)	27(17.9)	52(34.4)	53(35.1)	151	4.8	1.2
Vicarious Experience	4(2.6)	1(.7)	11(7.3)	30(19.9)	51(33.8)	54(35.8)	151	4.9	1.2
Verbal persuasion	2(1.3)	2(1.3)	11(7.3)	26(17.2)	53(35.1)	57(37.7)	151	5.0	1.1
Emotional	4(2.6)	5(3.3)	15(9.9)	28(18.5)	54(35.8)	45(29.8)	151	4.7	1.2
SELF-L	2(1.3)	4(2.6)	13(8.6)	34(22.5)	51(33.8)	47(31.1)	151	4.8	1.1

Option	No confidence at all	a little confidence	A fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using UCT data

5.2.1.6.3. Assessment scores for self-efficacy to learn statistics

Table 5.8 presents information from 151 respondents, ranged in SELS from ***1 to 3, with a mean of 1.64, and a standard deviation of .646. The skewness*** and kurtosis would be applied in further analysis (t-tests and analysis of variance). The positive skewness (.504) revealed that the scores clustered to the left, at the low values. Kurtosis scores below zero indicate that the distribution is relatively flat; however, with a reasonably large sample of 151, the skewness would not make a substantial change to the examination (Tabachnick & Fidell, 2007). The respondents were given two sub-sections in the evaluation of self-efficacy to complete, one to solve, and the other to learn. The absolute difference between the two instruments provides the ability to learn statistics (Schwartz & Martin, 2004). The response patterns in all the components (Table 5.6) reveal that, initially, the students had a similar “much confidence” score (Mean=4) in the understanding of these components and associated methods, which improved in Table 5.7, to become “very much confidence” (Mean=5). There are some indications that the difference was modest in promoting the respondents factual, conceptual and procedural understanding of measurement. Initially, SELS is a scale variable, as illustrated in Table 5.8.

Table 5.8: Distribution of current responses of SELS

N	Valid	151
	Missing	0
Mean		1.64
Std. Deviation		.646
Skewness		.504
Std. Error of Skewness		.197
Kurtosis		-.667
Std. Error of Kurtosis		.392
Minimum		1
Maximum		3

5.2.2. Reliability of the Scales

As mentioned earlier, the scales approved in this current study were reformed from scales used in previous studies. Since modifications were involved, the reliability of the scales could have been affected; therefore, it was compulsory to conduct reliability tests as to confirm the scales were reliable enough. After conducting the reliability tests, it was determined that the modified scales were quite reliable, as the Cronbach's Alpha coefficients ranged from .773 to .974 for each overall factor (see Table 7.9 in section 7.3). Therefore, even though the scales had been modified, they could still sustain a satisfactory level of reliability. In addition, a high value for Cronbach's Alpha indicates good internal uniformity of the items in the scale. Therefore, the analysis of the data should use these subscales and not individual items, failing which, the reliability of the items is, at best, probably low, and, at worst, unknown.

Validity evidence of self-efficacy was one-dimensional and reported. Table 7.9 indicates that internal consistency reliability for 'current self-efficacy' was reported as a Cronbach's Alpha of .959. In addition, for 'self-efficacy to learn', a Cronbach's Alpha of .974 was recorded. Concerning the 'experiences' component, the validity evidence of 'experiences' to other variables was reported. The reliability for each of the subscales ranged between .729 and .802 with 'experiences in statistics' at .729, and 'experiences in research methodology' at .802). The reliability of 'overall experiences' was .773. Regarding STARS, the reliability for each of the subscales ranged from .758 to .948, with 'worth of statistics at .892, 'interpretation anxiety at .897, 'test and class anxiety' at .927, 'computational self-concept' at .822, 'fear of asking for help' at .816, and 'fear of statistics teachers' at .758. The validity evidence of STARS to other variables was reported. The SATS was reported to have moderate concurrent validity with the Statistics Attitude Survey. SATS was sub-divided into six subscales. Each of the subscales was reported as reliable with Cronbach's Alpha coefficients at .543 for 'affect', .532 for 'cognitive competence,' .567 for 'value', .604 for 'difficulty', .853 for 'interest' and .889 for 'effort' (Wise, 1985).

Concerning the independent variable 'social support', the Multidimensional Scale of Perceived Social Support (MSPSS) (Zimet *et al.*, 1990) was applied. Three subscales, including 'support from significant others' (.856), 'support from family' (.899), and 'support from friends' (.917) were obtained. The instrument was reported as reliable with Cronbach's Alpha coefficients of .85 to .91 for the three subscales.

5.2.3. Impact of independent variables on Self-Efficacy to Learn Statistics

Overview: The impact of independent variables on the dependent variable was assessed using an independent samples test, or a One-way ANOVA, according to the number of categories of the independent variables. In fact, an independent variable with two groups applied an independent samples test, while an independent variable with more than two categories required a One-way ANOVA. Therefore, the *t*-test was called a "robust" test, since the sample size of the data was 151. The population variances were equal across responses for the group levels. This was evaluated by using the rule of thumb; if the largest sample standard deviation, divided by the smallest sample standard deviation, was not greater than two, it is assumed that the population variances were equal. In addition, given that the independent variable had three categories of responses, the size of each group should be, at least, 15, which was attempted in this current study. No outliers were found in the data. Each group represented an independent random sample, and the distribution of the responses followed approximately a normal distribution. 'Experiences' had three components (*experiences in research methodology*, *experiences in statistics* and *overall* experiences). The respondents' responses for experiences were rated as bad, average, or good. STARS involved *"interpretation anxiety"*, *"test and class"* anxiety, *"fear of asking help"* from peers, *"worth* *of statistics"*, *"fear of statistics"* monitors, and *"computational self-concept"*. The rating scale has three options, namely, low, moderate and high anxiety. "Attitudes" have six components, namely, *"affect"*, *"cognitive competence"*, *"value"*, *"difficulty"*, *"interest"* and *"effort"*. Attitudes are appraised according to low positive attitude, moderate positive attitude and high positive attitude. Social support included supports from *"family members"*, from *"friends"* and from *"significant others"*. Support responses are classified according to disagree, neutral and agree.

5.2.3.1. Impact of academic and demographic characteristics on SELS beliefs

Tables 5.9a and 5.9b below describe all results presented in this section. An "independent-samples t-test" was performed to compare the SELS beliefs scores for men and women. There was no important variance in scores for men (M = .770, SD = .832) and women (M = .729, SD = .570); t (149) = .272, p = .786, (two-tailed). The differences in the means (mean difference = .041, 95% CI: -.256 to .338) were very small (eta squared = .0005).

In addition, a similar test was done for "type of study", applying an "independent-samples t-test" to examine whether there was a substantial change between full-time and part-time students, which appears under t-test for equality of means. There was no significant difference in means' scores for full-time (M = .776, SD = .790) and part-time students (M = .592, SD = .562); t (148) = .688, p = .492, (two-tailed). The differences in the means (mean modification = .184, 95% CI: -.345 to -.714) were very small (eta squared = .003).

Table 5.9a: Group statistics

Academic & demographic variables		N	Mean	Std. Deviation	Std. Error Mean
SELS	Master	93	0.952	0.695	0.072
	PhD and Post-doc	55	0.923	0.969	0.131
	Single	105	0.937	0.767	0.075
	Married	32	1.034	0.95	0.168
	Male	116	0.938	0.854	0.079
	Female	35	0.896	0.609	0.103
	Full time	141	0.777	0.79	0.067
	Part time	9	0.592	0.562	0.187

Regarding “marital status”, the t-test was used to explore the SELS beliefs scores for single/divorced/widowed and married/cohabiting students. The results revealed that there was no statistically important difference in the means scores for single/divorced/widowed students (M = .937, SD = .767), and married/cohabiting students (M = 1.034, SD = .950); t (135) = -.589, p = .557, (two-tailed). The mean difference = -.097, 95% CI: [-.421 to .228]. The degree of the differences in the means was very small (eta squared = .0002), which indicates that the variance observed in SELS beliefs outcomes was not explained by the variation in marital status.

Table 5.9b: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI	
									Lower	Upper
SELS Mean - postgraduate programmes	Equal variances assumed	6.554	0.011	0.205	146	0.838	0.028	0.137	-0.243	0.299
	Equal variances not assumed			0.188	87.127	0.851	0.028	0.149	-0.268	0.325
SELS Mean - Marital status	Equal variances assumed	3.66	0.058	-0.589	135	0.557	-0.097	0.164	-0.421	0.228
	Equal variances not assumed			-0.525	44.026	0.602	-0.097	0.184	-0.467	0.274
SELS Mean - Gender	Equal variances assumed	1.736	0.19	0.272	149	0.786	0.042	0.155	-0.265	0.349
	Equal variances not assumed			0.325	78.194	0.746	0.042	0.13	-0.217	0.301
SELS Mean -	Equal variances assumed	0.575	0.45	0.688	148	0.492	0.184	0.268	-0.345	0.714
	Equal variances not assumed			0.928	10.137	0.375	0.184	0.199	-0.257	0.626

In addition, an “independent-samples t-test” was conducted to determine the SELS ratings for MA and PhD/post-doctorate students. There was no noteworthy change in ratings for MA (M = .792, SD = .695) and PhD/post-doctorate students (M = .951, SD = .695); t (146) = .188, p = .851 (two-tailed). The change in the mean ratings (mean change = .028, 95% CI: -.268 to .325) was very slight (eta squared = .0002).

An “independent-samples t-test” was performed to determine whether there was a major modification in the SELS mean scores of both groups and each of these academic and demographic variables (gender, marital status, postgraduate programmes, and type of study). However, all revealed that there was no statistical major modification in the means scores of SELS both groups for each academic and demographic variables.

Further analyses deal with comparison, using a "One-way ANOVA test". Among background information, three variables (age group, ethnic group and student status) having more than two groups. A "One-way, ANOVA test", was directed to investigate the influence of 'age group' on the levels of SELS beliefs. The respondents were divided into four groups, according to their age (group 1: 20-25yrs; group 2: 26 to 30yrs; group 3: 31 to 40yrs; group 4: 41yrs and above). For the regularity of variance, Levene's test $p = .297$ indicated that the modification in scores is the same for each of the four groups. There was no statistically meaningful difference at the $p < .05$ level in SELS scores for the four age groups: $F(3, 147) = .064$, $p = .979$, (See Tables 5.9c and 5.9d).

Table 5.9.c: Test of homogeneity of variances

Variables	Levene Statistic	df1	df2	Sig.
Age group	1.240	3	147	.297
Ethnic group	1.676	3	147	.175
Student status	.744	2	146	.477

As well, similar a "One-way ANOVA test" was lead to explore the influence of *ethnic group* on the levels of SELS beliefs. Once again, the respondents were separated into four groups, conferring to their ethnic (group 1: African; group 2: Coloured; group 3: Indian; group 4: White). The significance value for Levene's test was $p = .175$, greater than .05, indicating no violation assumption of the homogeneity of variance. There was no statistically important difference at the $p < .05$ level in SELS beliefs' scores for the four *ethnic groups*: $F(3, 147) = 1.034$, $p = .379$. The actual difference in mean scores between the groups represented minor, however, the effect size, designed using eta squared, was .02 (Retrieved from Tables 5.9c and 5.9d).

Moreover, a "One-way ANOVA test" was conducted to examine the impact of *"student status"* on levels of SELS beliefs. The respondents were divided into three sets according to their student status (set 1: South African; set 2: African; set 3: Non-African). The Levene's test of homogeneity revealed no violation of assumption of equal variances (p = .477). There was a statistically substantial difference at the $p < .05$ level in SELS beliefs' scores for the three student status groups: F (2, 146) = .550, p = .578. The effect size, calculated using eta squared, was .007 (See Tables 5.9c and 5.9d).

Table 5.9.d: ANOVA

Variables		Sum of Squares	df	Mean Square	F	Sig.
Age group	Between Groups	.126	3	.042	.064	.979
	Within Groups	96.458	147	.656		
	Total	96.584	150			
Ethnic group	Between Groups	1.996	3	.665	1.034	.379
	Within Groups	94.588	147	.643		
	Total	96.584	150			
Student status	Between Groups	.717	2	.359	.550	.578
	Within Groups	95.252	146	.652		
	Total	95.969	148			

5.2.3.2. Impact of STARS on SELS

Given that the *"worth of statistics"*, *"fear of statistics"* monitors and *"computational self-concept"* were not variables, the students scored the same value. STARS was refined into three components namely, SITSTATS, STASTATS and overall STARS, assessing the emotions of the respondents, regarding statistics learning. However, the respondent beliefs were assembled into two categories: group 1 (low anxiety), group 2 (moderate/high anxiety). The assumptions enumerated in section 5.2.3.2 were achieved. The results presented in this section are retrieved from Tables 5.10a and 5.10b).

An "independent samples t-test" was directed to determine if there was a modification in the means scores of SELS beliefs, according to SITSTATS categories. The analytical test revealed that there was no major modification in the means ratings for low anxiety students (M = 4.910, SD = 1.112), and moderate/high anxiety students (M = 4.570, SD = 1.158); t (2, 149) = 1.755, p = .081, two tailed. The degree of the changes in the means (mean difference = .334, 95% CI: [-.042 to .710] was small (eta squared = .02).

Table 5.10a: Group statistics

STARS			N	Mean	Std. Deviation	Std. Error Mean
SELS	SITSTATS	Low anxiety	95	4.91	1.112	.114
		Moderate & High anxiety	56	4.57	1.158	.155
	STASTATS	Low anxiety	133	4.89	1.042	.090
		Moderate & High anxiety	18	4.00	1.495	.352
	STARS	Low anxiety	123	4.93	1.084	.098
		Moderate & High anxiety	28	4.11	1.133	.214

In addition, an "independent-samples t-test" was directed to associate the SELS beliefs scores for STASTATS groups. There was a statistically substantial change in scores for students with low anxiety (M = 4.89, SD = 1.042) and students with moderate/high anxiety (M = 4.00, SD = 1.495); t (149) = 3.202, p = .002, two-tailed. The magnitude of the change in the means (mean difference = .887, 95% CI: [.340 to 1.435] was moderate (eta squared = .06).

Table 5.10b: Independent samples test

		Levene's Test for Equality		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
SELS Mean - SITSTATS	Equal variances assumed	.184	.668	1.755	149	.081	.334	.190	-.042	.710
	Equal variances not assumed			1.737	111.718	.085	.334	.192	-.047	.715
SELS Mean - STASTATS	Equal variances assumed	2.633	.107	3.202	149	.002	.887	.277	.340	1.435
	Equal variances not assumed			2.439	19.298	.025	.887	.364	.127	1.648
SELS Mean - STARS	Equal variances assumed	.086	.770	3.615	149	.000	.828	.229	.375	1.280
	Equal variances not assumed			3.516	39.053	.001	.828	.235	.352	1.304

Furthermore, a similar t-test was investigated to compare the SELS beliefs scores for the overall STARS groups. The findings revealed that there was a statistically important variance in ratings for low anxiety students (M = 4.93; SD = 1.084) and moderate/high students (M = 4.11; SD = 1.133); t (149) = 3.615, p = .000, two tailed. The greatness of the variance in the means (mean difference = .828, 95% CI: [.375 to 1.280] was moderate (eta squared = .08).

Although, STASTATS and overall STARS components presented different trends, there were statistically meaningful variances in the means scores of SELS beliefs, which assumed that the change observed on SELS beliefs might be explained by both STASTATS and overall STARS.

5.2.3.3. Impact of experiences on SELS beliefs

All results presented in this section are retrieved from Tables 5.11a, 5.11b and 5.11c.
Regarding the *experiences in research methodology*, a "Oone-way ANOVA test" was conducted to investigate its influence on the SELS beliefs scores. The students were allocated into three categories, according to their experiences (category 1: bad; category 2: average; category 3: good). There was a statistically significant difference at the p < .05 level in SELS beliefs scores for the three groups, F (2, 148) = 4.769, p = .010. The actual alteration in mean scores among the categories was quite considerable. The effect size, designed using eta squared, was .06, which represents a moderate effect size (Cohen, 1988).

Multiple comparisons, using the Tukey HSD test indicated that the mean rating for category 1 (M = 2.101, SD = .579) was significantly different from category 3 (M= .689, SD = .754). Unfortunately, category 2 (M = 1.090, SD = .839) did not differ meaningfully from either category 1 or category 3.

Table 5.11a: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Experience Rmeth	.851	2	148	.429
Experience stats	2.157	2	148	.119
Experience	.752	2	148	.473

Regarding the effect of *experiences in statistics* on SELS beliefs, a "One-way ANOVA test" was conducted. Using the same scale, the respondents were shared into three sets, according to their *experience in statistics* (Set 1: bad; Set 2: average; Set 3: good). The findings revealed that there was a statistically substantial change at the $p < .05$ level in self-efficacy scores for experience in the three Sets: $F (2, 148) = 3.478$, $p = .033$.

Table 5.11b: ANOVA experiences

		Sum of Squares	df	Mean Square	F	Sig.
ExpRmeth	Between Groups	5.847	2	2.924	4.769	.010
	Within Groups	90.737	148	.613		
	Total	96.584	150			
Expstats	Between Groups	4.335	2	2.168	3.478	.033
	Within Groups	92.249	148	.623		
	Total	96.584	150			
Experience	Between Groups	3.252	2	1.626	2.578	.079
	Within Groups	93.332	148	.631		
	Total	96.584	150			

Despite reaching statistical implication, the genuine alteration in mean ratings among the sets was fairly small. The effect size, deliberate using eta squared, was small (.04). Post-hoc comparisons using the LSD test, revealed that the mean score for only set 2 ($M = 1.70$, $SD = .787$) was expressively different from Set 3 ($M = .779$, $SD = .751$). Set 1 ($M = 1.291$, $SD = 1.084$) did not differ knowingly from either set 2 or 3.

Subsequently, the output for the SPSS one-way procedure, to compare the mean scores of the three categories for the *overall* experiences, was assessed to determine whether there was a statistically important change in the midst of groups on SELS beliefs means scores. Essentially, there was no important difference in SELS beliefs means, $F (2, 153) = 2.578$, $p = .079$, with the Levene's statistics test $p = .473$, indicating no violation assumption of similarity of variances.

Table 5.11c: Multiple comparisons

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
ExpRmeth	Tukey HSD	Bad	Average	1.011	.471	.084	-.103	2.1247
			Good	1.256	.458	.019	.171	2.3405
		Average	Bad	-1.011	.471	.084	-2.125	.1032
			Good	0.245	.150	.234	-.110	.6004
		Good	Bad	-1.256	.458	.019	-2.341	-.1715
			Average	-0.245	.150	.234	-.600	.1099
Expstats	LSD	Bad	Average	0.222	.270	.412	-.311	.7546
			Good	0.513	.265	.055	-.010	1.0358
		Average	Bad	-0.222	.270	.412	-.755	.3112
			Good	0.291	.134	.032	.025	.5569
		Good	Bad	-0.513	.265	.055	-1.036	.0100
			Average	-0.291	.134	.032	-.557	-.0254
Experience	Tukey HSD	Bad	Average	-0.287	.573	.871	-1.644	1.0706
			Good	0.031	.567	.998	-1.312	1.3730
		Average	Bad	0.287	.573	.871	-1.071	1.6442
			Good	0.317	.140	.064	-.014	.6489
		Good	Bad	-0.031	.567	.998	-1.373	1.3118
			Average	-0.317	.140	.064	-.6489	.0140

5.2.3.4. Impact of SATS on SELS

SATS comprises *"affect"*, *"cognitive competence"*, *"value"*, *"difficulty"*, *"interest"*, and *"effort"* components, as well as the *overall* SATS. The respondents' attitudes were grouped into three groups, namely, group 1 (less positive attitude), group 2 (moderate positive attitude) and group 3 (more positive attitude). All the assumptions were attempted, as mentioned above in section 5.2.3.2. A "One-way ANOVA test" was applied to investigate the influence of attitudes towards statistics (SATS) on SELS beliefs scores. All the results displayed in this section are in Tables 5.12a, 5.12b, 5.12c and 5.12d.

Regarding the *"effort"*, the findings revealed a statistically substantial modification in the means scores: F (2, 148) = 10.936, p = .000. In addition, the effect size was .13; fairly large, according to the Cohen's classification.

Table 5.12a: Test of homogeneity of variances

Component	Levene Statistic	df1	df2	Sig.
Affect	1.374	2	148	.256
Cognitive competence	1.063	2	148	.348
Value	2.816	2	148	.063
Difficulty	2.320	2	148	.102
Interest	.136	2	148	.873
Effort	7.603	2	148	.001
SATS	1.196	2	148	.305

Multiple comparisons, using the Tukey HSD test, indicated that a difference in means score is observed with group 1. In fact, group 1 (M = 1.768, SD = 1.221) was statistically diverse from either group 2 (M = 1.044, SD = .859), and group 3 (M = .786, SD = .639), while group 2 did not fluctuate from group 3. The analysis also revealed that, concerning the *"affect"* component, there was no statistically meaning in means difference at the $p < .05$ level in SELS beliefs scores for the three attitude groups: $F(2, 148) = .286$, $p = .751$. The actual change in mean scores between the groups did not represent much. The effect size, considered using eta squared, was .004.

Table 5.12b: Robust tests of equality of means

		Statistic*	df1	df2	Sig.
Effort	Welch	5.131	2	27.025	.013
	Brown-Forsythe	6.028	2	27.840	.007

* Asymptotically F distributed

The outcomes of the investigation of variance in attitude scores on levels of SELS indicated that, for *"cognitive competence"*, there was no statistically noteworthy modification at the $p < .05$ level in SELS scores for the three groups: $F(2, 148) = .507$, $p = .603$. Therefore, the concrete modification in mean scores between the groups could not explain the change observed in SELS scores. In addition, the *"value"* factor produced a similar result, with no statistically noteworthy modification at the $p < .05$ level in SELS scores for the three age groups: $F(2, 148) = 1.516$, p =

.223. The current difference observed in mean scores between the groups was negligible. The effect size, deliberate using eta squared, was .02.

The *"difficulty"* results achieved no statistically major difference in SELS scores for the three *difficulty* clusters: F (2, 148) = 2.558, p = .081, at the P > .05 level, which indicated no major change in mean ratings concerning the clusters. The effect size, calculated using eta squared, was .03, small.

Table 5.12c: SATS ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Affect	Between Groups	.372	2	.186	.286	.751
	Within Groups	96.212	148	.650		
	Total	96.584	150			
Cognitive competence	Between Groups	.657	2	.329	.507	.603
	Within Groups	95.927	148	.648		
	Total	96.584	150			
Value	Between Groups	1.939	2	.969	1.516	.223
	Within Groups	94.645	148	.639		
	Total	96.584	150			
Difficulty	Between Groups	3.227	2	1.614	2.558	.081
	Within Groups	93.357	148	.631		
	Total	96.584	150			
Interest	Between Groups	.914	2	.457	.707	.495
	Within Groups	95.670	148	.646		
	Total	96.584	150			
Effort	Between Groups	12.435	2	6.218	10.936	.000
	Within Groups	84.148	148	.569		
	Total	96.584	150			
SATS	Between Groups	3.567	2	1.783	2.837	.062
	Within Groups	93.017	148	.628		
	Total	96.584	150			

About the *"interest"*, there was no statistically considerable variance at the p < .05 level in SELS beliefs scores for the three "*interest"* clusters: F (2, 148) = .707, p = .495. Therefore, p > .05 displayed no statistical noteworthy difference in mean scores between the clusters. The real variance in mean scores between the clusters represented nothing. The effect size, designed using eta squared, was .009.

Finally, the *overall* SATS results revealed no influence of attitudes on the levels of SELS beliefs. There was no statistically meaningful variance at the $p < .05$ level in the SELS beliefs scores for the three *overall* SATS categories: $F(2, 148) = 2.837$, $p = .062$. Despite not reaching statistical meaning, the current change in mean ratings between the categories was quite trifling. The effect size, calculated using eta squared, was .04.

Table 5.12d: Post Hoc Tests

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Affect	Tukey HSD	Low	Moderate	.109	.149	.742	-.242	.461
			High	.075	.175	.903	-.338	.489
		Moderate	Low	-.109	.149	.742	-.461	.242
			High	-.034	.183	.981	-.467	.399
		High	Low	-.075	.175	.903	-.489	.338
			Moderate	.034	.183	.981	-.399	.467
Cognitive comp.	Tukey HSD	Low	Moderate	.032	.144	.974	-.308	.372
			High	.188	.189	.581	-.259	.636
		Moderate	Low	-.032	.144	.974	-.372	.308
			High	.157	.192	.693	-.297	.610
		High	Low	-.188	.189	.581	-.636	.259
			Moderate	-.157	.192	.693	-.610	.297
Value	Tukey HSD	Low	Moderate	.022	.150	.988	-.333	.377
			High	.409	.236	.197	-.150	.968
		Moderate	Low	-.022	.150	.988	-.377	.333
			High	.387	.255	.287	-.218	.991
		High	Low	-.409	.236	.197	-.968	.150
			Moderate	-.387	.255	.287	-.991	.218
Difficulty	Tukey HSD	Low	Moderate	-.129	.171	.734	-.534	.277
			High	.204	.182	.501	-.226	.634
		Moderate	Low	.129	.171	.734	-.277	.534

			High	.333	.147	.065	-.016	.681
		High	Low	-.204	.182	.501	-.634	.226
			Moderate	-.333	.147	.065	-.681	.016
Interest	Tukey HSD	Low	Moderate	.319	.305	.549	-.403	1.040
			High	.295	.253	.477	-.305	.894
		Moderate	Low	-.319	.305	.549	-1.040	.403
			High	-.024	.198	.992	-.494	.446
		High	Low	-.295	.253	.477	-.894	.305
			Moderate	.024	.198	.992	-.446	.494
Effort	Tukey HSD	Low	Moderate	.724	.244	.010	.146	1.301
			High	.982	.214	.000	.474	1.489
		Moderate	Low	-.724	.244	.010	-1.301	-.146
			High	.258	.156	.225	-.111	.627
		High	Low	-.982	.214	.000	-1.489	-.474
			Moderate	-.258	.156	.225	-.627	.111
SATS	Tukey HSD	Low	Moderate	.333	.199	.220	-.139	.805
			High	.530	.223	.049	.002	1.057
		Moderate	Low	-.333	.199	.220	-.805	.139
			High	.197	.152	.403	-.164	.557
		High	Low	-.530	.223	.049	-1.057	-.002
			Moderate	-.197	.152	.403	-.557	.164

5.2.3.5. Impact of social support on SELS beliefs

Social support comprised four components; namely, support from *"significant others"*, *"family members"*, *"friends"* and the *overall* social support. The responses were separated into three categories, according to their support level (category 1: disagree; category 2: neutral; category 3: agree). A "One-way ANOVA test" was conducted to determine the influence of social support components on levels of SELS beliefs. The findings presented in this section are summarised in Tables 5.13a,b,c.

As far as the support from *"significant others"* was concerned, the findings revealed that there was no statistically important modification at the $p < .05$ level in SELS beliefs scores for the three support categories: $F(2, 148) = 1.424$, $p = .244$. Levene's test for homogeneity of variances revealed that the assumption was not violated ($p = .402$). Despite not accomplishment statistical implication, the genuine change in the mean scores between the categories was quite slight, with an eta squared at .02.

Table 5.13a: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Significant others	.918	2	148	.402
Family	.036	2	148	.965
Friends	3.517	2	148	.032
Social support	.239	2	148	.787

Similarly, the analysis of support from *"family members"* indicated no statistically noteworthy variance at the $p < .05$ level in SELS beliefs ratings for the three "*family members"* support clusters: $F (2, 148) = 1.076$, $p = .344$, with Levene's test of homogeneity at $p = .965$. The observed difference in the mean ratings between the clusters was quite minor. The effect size, using eta squared, was .01. However, support from *"family members"* might not explain the variance in SELS scores.

Table 5.13b: Robust tests of equality of means

	Statistic*	df1	df2	Sig.
Welch	1.136	2	13.632	.350
Brown-Forsythe	1.254	2	23.834	.303

* Asymptotically F distributed

Referring to support from *"friends"*, the test of consistency of adjustments exposed a destruction of assumption; therefore, the robust tests of equality of means were applied, with Welch presenting $p = .350$, and Brown-Forsythe, $p = .303$. The outcomes of the "One-way ANOVA test" revealed that there was no statistically substantial difference in SELS beliefs scores for the three supports from *"friends"* groups: $F (2, 148) = 1.629$, $p = .200$. The variance in the mean scores between the categories was very slight and did not affect the variation. The effect size, designed using eta squared, was .02.

The *overall* social support presented no violation of assumption, with Levene's test of homogeneity of adjustments at $p = .787$. The results of "One-way ANOVA test" discovered that there was no statistically noteworthy alteration at the $p < .05$ level in SELS beliefs ratings for the three overall social support categories: $F (2, 148) = 1.038$, p = .357. No statistical evidence was established regarding the current difference in mean scores between the categories. The effect size using eta squared was .01.

The results revealed no statistically main dissimilarity among the mean for all categories of support components, indicating that the differences observed between the means were likely due to other factors.

Table 5.13c: Social support ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Significant others	Between Groups	1.824	2	.912	1.424	.244
	Within Groups	94.760	148	.640		
	Total	96.584	150			
Family	Between Groups	1.384	2	.692	1.076	.344
	Within Groups	95.200	148	.643		
	Total	96.584	150			
Friends	Between Groups	2.080	2	1.040	1.629	.200
	Within Groups	94.504	148	.639		
	Total	96.584	150			
Social support	Between Groups	1.336	2	.668	1.038	.357
	Within Groups	95.248	148	.644		
	Total	96.584	150			

5.2.4. Results of Multivariate Analysis

In this current study, the ordinal regression method was used to model the relationship between the ordinal outcome variable, for example, the different levels of students' SELS, in terms of the application of statistical procedures in their academic work, as well as the explanatory variables concerning demographics, experiences, emotion, behaviour and environment factors. The outcome variable for students' ability was an ordinal response variable, measured on an ordered way. The main choices taken in the model structure for "ordinal regression" were, determining which explanatory factors to include in the model, as well as selecting the link meaning that established the model suitability. It is unbearable to accept the normality and homogeneity of the adjustment for well-organized categorical outcome. The investigation of the distribution of values for SELS beliefs enables students to choose the relevant link function that provides the most suitable fit for the data. The histogram for the dependent variables illustrates that the outcomes are consistently distributed in categories (see Figure 5.8). Therefore, the logit link function is applied to ensure that the distribution of outcomes is reliable.

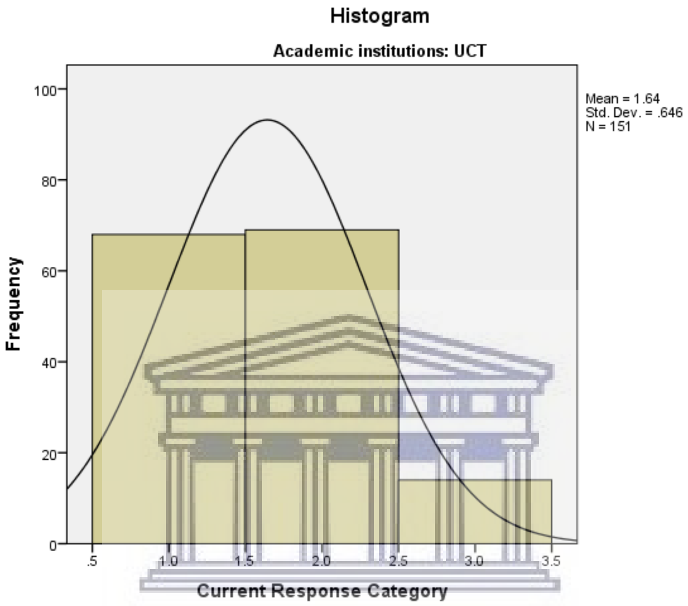


Figure 5.8 Distribution of students' overall self-efficacy to learn statistics at UCT

5.2.4.1. Predictive value of the model

The complete model, using the Logit Link function, examined 100 of the 151 questionnaires, and excluded 51 questionnaires from the study, due to the existence of at least one item with missing data, or 'not applicable' rating. The complete model, containing all the factors and co-variates (items), revealed a number of interesting findings. The difference between the two log-likelihoods revealed significant chi-square statistics.

Table 5.14 Model-fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	186.649			
Final	123.009	63.640	31	.000

Link function: Logit

Therefore, the model fitting information indicated a significant improvement over the baseline intercept-only model, with p = .000 (See Table 5.14). The predictions were suited, rather than assumed, based on the probabilities for the outcome categories.

5.2.4.2. Test of parallel lines

The assumption was that the slope coefficients were approximately the same for all response categories. The findings confirmed that there was not sufficient evidence to reject the parallelism hypothesis. Therefore, the observed significance level in Table 5.15 was large (p= .788, greater than .05). An ordering that places “little confidence” as a greater value may have a better fit.

Table 5.15 Test of parallel lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	123.009			
General	98.474[b]	24.535[c]	31	.788

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

5.2.4.3. Pseudo R-squared measures

Some approximations are computed as a replacement for the coefficient of determination, R^2 (Smith & McKenna, 2013). These approximations (pseudo R-squareds) are described in Table 5.16. Based on this standard, Nagelkerke/Cragg and Uhler’s study achieved the highest report, with 55.7%, followed Cox and Snell with 47.1%, and McFadden, who reported the smallest approximation of 34.1% (Cohen, Cohen, West & Aiken, 2013; Smith & McKenna, 2013).

Table 5.16: Pseudo R-squared measures

Nagelkerke/Cragg and Uhler	.557
Cox and Snell	.471
McFadden	.341

Link function: Logit

The best fitting model is the model with the largest statistics. In Table 5.16, the approximation of Nagelkerke/Cragg and Uhler (R^2) was the best, with 56%.

5.2.4.4. Classification table

This section focuses on the assessment of ordered response variables, since whether or not the ordering is relevant for the regression relationship, is significant. A confusion matrix in Table 5.17 describes the cross-tabulation of the expected groups with the actual groups. The model with the logit link accurately predicts the outcomes categories as follows: category 1: 75.6%, category 2: 78.3% and category 3: 33.3%. The models appropriately complete a high prediction accuracy of 73% for all three categories combined.

Table 5.17: Confusion matrix for the initial model

Current response Categories		**Predicted Response Categories**			**Total**
		A little confidence	**A fair amount of confidence**	**Much confidence**	
A little confidence	n	34	10	1	45
	% within Current Response Category	75.6%	22.2%	2.2%	100.0%
A fair amount of confidence	n	8	36	2	46
	% within Current Response Category	17.4%	78.3%	4.3%	100.0%
Much confidence	n	1	5	3	9
	% within Current Response Category	11.1%	55.6%	33.30%	100.00%
Total	**N**	**43**	**51**	**6**	**100**
	% within Current Response Category	**43.0%**	**51.0%**	**6.0%**	**100.00%**

5.2.4.5. Interpreting the model

Evaluating the complete model with the logit link revealed that the two thresholds of the model equation were significantly different from zero, and substantially contributed to the values of the response probability in different categories. In addition, the overall SELS was significantly associated with the four explanatory variables, namely, fear of statistics teacher, postgraduate programmes, engineering department and health & wellness department. Except for the fear of statistics teacher, these significant explanatory variables revealed positive regression coefficients, indicating that students, who scored higher levels of satisfaction on these explanatory variables, were likely to be rated at a higher level for the overall SELS. In the same manner, the students who scored lower levels of fulfilment on these descriptive variables, were probable to be rated at a lower level for the overall SELS beliefs. Table 5.18 shows that of these four approval items on the overall SELS beliefs, 75% or 3 satisfaction items were related to academic factors (postgraduate programmes, engineering department, health & wellness department). In addition, 25 percent or 1 item was related to emotion factors (fear of statistics monitors).

Table 5.18: Parameter estimates

Item names	R. coeff.	P-value		Item names	R. coeff.	P-value
[SelfEffAbsMeanOrd = 1]	5.185	.041		Marital status	.434	.523
[SelfEffAbsMeanOrd = 2]	9.231	.001		Postgraduate prog.	2.001	.003
Experiences in Stats	-.505	.218		Student status=0	-.072	.941
Test factor	-.182	.703		Student status=1	-.725	.463
Interpretation factor	.575	.389		gender	1.006	.218
Ask for help factor	-.884	.146		Type of study	.951	.517
Self-concept factor	.565	.288		Applied Science=1	-16.243	.998
Teacher factor	-1.109	.045		Bus & Manag=2	2.249	.225
Affect factor	.949	.065		Education=3	3.278	.289
Cognitive compet.	-.878	.164		Engineering=4	7.364	.001
Value factor	-.876	.065		Health& wellness=5	3.612	.035
Interest factor	-.144	.739		Art & humanity=7	1.280	.420
Effort	-.770	.090		EMS	3.071	.084
Support- Others	-.283	.519		Natural science=10	2.719	.067
Family support	-.466	.320		Law =11	2.456	.103
Friend support	.103	.804				

The significance of the test for postgraduate programmes was less than .05 (p = .003), signifying that its experiential effect was not due to coincidental. Since its coefficient was confident, as postgraduate programmes increase, so does the likelihood of being in one of the groups of the overall SELS beliefs. In addition, the engineering department displayed a significance in the test with P = .001, indicating that the overall SELS beliefs was associated with the engineering department explanation. Therefore, being a student from engineering department explained the effect of variation observed in the overall SELS beliefs, and as engineering department increases, the probability of being in one of the categories of the overall self-efficacy to learn statistics increases, as well. Similarly, the health and wellness department was statistically significant with p = .035. Its coefficient was positive, revealing that the change observed in the overall SELS beliefs was associated with the change in the health and wellness department. This means health and wellness department decreases, or increases, simultaneously, with the probability of being in one categories of the overall SELS beliefs. However, the fear of statistics teachers factor was only slightly significant (p = .045).

It contributed meaningfully in the model with a negative coefficient, revealing an inverse direction in the improvement of factors. Students with high levels of "fear of statistics" teachers were related with low level of SELS beliefs. None of the items regarding behaviour, social support, prior knowledge and socio-demographic factors was significantly associated with the overall SELS beliefs. However, the minor effects of each category of these items accumulated and provided useful information to the model.

5.2.4.6. Predictive value of the model using Cauchit Link function

Comparable to linear and logistic regression modelling procedures, the principle of meanness, was appropriate to the building of the best "ordinal regression" model (Smith & McKenna, 2013). In this sense, the complete model, using the Cauchit Link function, investigated 101 of the 151 questionnaires, and excepted 50 questionnaires from the study, due to the existence of at least one question with missing information, or 'not applicable' score.

Table 5.19: Model-fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	188.191			
Final	120.594	67.596	30	.000

Link function: Cauchit

In Table 5.19, the researcher provides an illustration that the model afforded appropriate predictions. The difference between the two log-likelihoods was significant. Therefore, the model fitting revealed a substantial improvement over the reference point intercept-only model with $\chi 2$ = 67.596, a d.f. of 30 and p = .000.

5.2.4.7. Pseudo R-squared measures

Three pseudo R-squared measures are presented in Table 5.20, revealing that the model with Cauchit Link fits the outcome data. Nagelkerke/Cragg and Uhler's displayed the best measure (58%), followed by Cox and Snell's (49%), with McFadden's (36%), the smallest (Cohen *et al.*, 2013; Smith *et al.*, 2013). According to the standard, Cox & Snell's pseudo R-squared measure has a extreme value of less than one, while Nagelkerke/Cragg & Uhler's R-squared measure is the complete model that perfectly predicts the result and has a probability of 1. However, the highest pseudo R-squared measure represents the best model to estimate the effect.

Table 5.20: Pseudo R^2

Cox and Snell	.488
Nagelkerke/Cragg and Uhler	.578
McFadden	.359

Link function: Cauchit

5.2.4.8. Test of parallel lines

The full model with the Cauchit link is unsuccessful to deliver the indication of sustaining "parallel lines" statement (see Table 5.21), implying that meeting could not be extended according to the SPSS printout; therefore, the research discoveries stated above are needless. Therefore, it is preventable to prepare a table that contains item name, regression coefficient, and p-value in this sub-section.

Table 5.21: Test of Parallel Lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	120.594			
General	154.710[b]	.[c]	30	

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Cauchit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The log-likelihood value of the general model is smaller than that of the null model. This is because convergence cannot be attained or ascertained in estimating the general model. Therefore, the test of parallel lines cannot be performed.

There is no specific technique to determine the favorite of using different link functions. The model with the Cauchit Link function has definite limitations. Despite the circumstance that the model suitable information was significant (χ^2 = 67.596 with d.f. of 30 and p = .000), the table of pseudo R^2 displayed higher values in the three measures, specifically, McFadden (35.9%), Cox and Snell (48.8%) and Nagelkerke/Cragg and Uhler (57.8%). In addition, the model with the Cauchit Link function was not particularly reliable, and was unable to assist in estimating the general model. Consequently, the model with the Logit Link function produced good fits for the data, and was generally appropriate for analysing the ordered categorical data, evenly dispersed between all categories.

5.2.4.9. Correlation estimated classification probability between predicted and actual category

A further investigation of the model with the Logit Link function was conducted, as it was the best model. A "Spearman's rho correlation" coefficient was applied to investigate the association between the predicted and actual category. A strong positive correlation of the estimated classification probability between predicted and actual category, rho = .709, p < .000, n = 100 is illustrated in Table 5.22.

High levels of estimated classification probability for a predicted category are associated with high levels of estimated classification probability for the actual category. The strength of the relationship represented 50.27%. The estimated classification probability for the predicted category may explain the 50.27% in the variance of the estimated classification probability for the actual category, which is remarkable. A positive correlation coefficient implies that a high increase in predicted category is connected with high upsurge in actual category, and vice versa.

Table 5.22: Correlation between predicted and actual category

			Estimated Classification Probability for the Predicted Category	Estimated Classification Probability for the Actual Category
Spearman's rho	Estimated Classification Probability for the Predicted Category	Correlation Coefficient	1.000	.709**
		Sig. (2-tailed)		.000
		N	100	100
	Estimated Classification Probability for the Actual Category	Correlation Coefficient	.709**	1.000
		Sig. (2-tailed)	.000	
		N	100	100

** Correlation is significant at the 0.01 level (2-tailed)

5.3. Qualitative Findings

This section highlights the answers of the one-on-one, in depth interviews, preceded by "3-hour-long tasks" questionnaire, that the postgraduate students at UCT were required to complete. The first part concerns with a description of the participants' characteristics. The second part involves transcribed and reported qualitative data. The results are discussed in Chapter 8 of this thesis.

5.3.1. Description of the study participants' characteristics

The sample size of the participants for the qualitative phase was twelve. Two respondents (female and male) withdrew during the data collection process. Only ten participants successfully completed the interview process. The study sample included two females (white and Black) and eight males (one white and seven Black). Five participants held MA degrees, four PhDs, and one held post-doctorate status. Five participants were under thirty years of age, three were aged between thirty and forty-five years and two were older than 45. Remarkably, these students were involved in teaching assistance, particularly, tutoring undergraduate level statistics at UCT.

5.3.2. Participant Responses

The semi-structured interviews, which included the qualitative questionnaire with open-ended questions, provided real insights into the key issues perceived by the postgraduate students of UCT. All the responses from the ten participants (Resp.1-10) are summarised below, in response to the semi-structured questions:

How did you decide to choose the test? Or on what basis did you choose the test that you have chosen?

Resp. 1: *"Humm, based on my first year Stats course, three semesters of stats, so I know something about stats, but I'm like, about four years ago, and, and then any other experience I've had, was straight the research."*

Resp. 2: *"Humm, it depends on the parameters that I would have there are two groups I just know that if one is dependent or not I will know the test.*"

Resp. 3: *"Humm, in general that it is in general you can say as what it is asking for like the measurement, the measures, then also the guide of methods that was supposed in that particular study, and then also the sample size for sampling frame so those are straight things that I am looking at to decide which one to choose."*

Resp. 4: *"I looked at the method that it is appropriate so applied to the problem at time."*

Resp. 5: "*So, I look at the type of the question that you are trying to ask, and if you are looking or if you are trying to investigate the effect size, then looking for something regression you are trying to test like the relationship between two things that it is probably a t-test or something that's sort of like a guideline for that.*"

Resp. 6: "*Humm well I first checked the third question required a parametric or non-parametric answer and that's why I decided to choose a certain test.*"

"*Well, I first decide like I look at the question and see whether it needs to be a parametrical or non-parametric method that you implemented from there I then choose the suitable test then splitting it between the two groups and then decide which test it is more appropriate for the data.*"

Resp. 7: "*Ok I just tried to remember some of the things that I previously on courses I took in statistics and then some work that I have done on my research, previous research based on what I have done in the past, that's what influence my decision.*"

Resp. 8: "*Thank you for taking my time."*

"*Yes, the first thing is no matter what I will do is to look at the analyzing principles, the questions that you want to answer, and then you look at the tiers that would allow you to answer such the questions. So that is what I use to analyse what I choose the answers that I choose for the various scenarios but I didn't have enough time to sub-check each scenario or proper structure also of these could not be exactly what I will be doing right in the real science you know if I have time enough, you know, yeah*."

Resp. 9: "*First with the available data, I have made different comparisons, qualitative data and quantitative data, I deal with one group or two groups, then the group of dependent and the group of independent, the data related like in which …different of means …"*

Resp. 10: "*I choose to answer the tests based on the knowledge first that I have about statistics and which relevant topics that applied to certain, humm certain description of data or information that I have to deal with.*"

Which information in the item alerted you to that choice? What did the test tell you?

Resp. 1: **"***Humm, based on the description with each question, humm, I sort of worked out on how many variables there were and then any table was given, humm, I tried to relate that back to something that I had seen before, based on the Stats course I did. So, for example if there was just a simple two independent groups to test, I would use a t-test. So that's what I would, that's how I would answer the question.*"

Resp. 2: **"***Euehe, information in the items, eumm, the variables, and then the numbers.*"

Resp. 3: **"***So, I think the outcome measures may cope the statistics I hope the statistics yah, the one that actually let me decided which one to cope for.*"

Resp. 4: **"***So most of the questions concerned humm comparisons and associations, so you look at the two items what are they interesting, so the next thing you have to do if are they qualitative or are they quantitative, so you based what test to use on the qualitative and the quantitative and then what you want to achieve.*"

Resp. 5: **"***So, I look at the type of the question that you are trying to ask, and if you are looking or if you are trying to investigate the effect size, then looking for something regression you are trying to test like the relationship between two things that it is probably a t-test or something that's sort of like a guideline for that.*"

Resp. 6: **"***Humm, the question and what you're trying to estimate so if the one say what you are trying to predict and the data presented.*"

Resp. 7: **"***Most of the time I saw words like predictive statistics or maybe uummm ahhh what's statistical procedure. And those I would like to use to say which one of the test that about listed here that which of them is possible right statistical test to use.*"

"*Humm, sorry, I don't get it.*"

"*Most of the time it writes either the T statistics, the P value or the F statistics or and Chi-square and value, I am trying to remember the one for statistics for Chi-square now. But I know it either F statistics or T stats and P value and then maybe x-square stats yeah for chi-square yeah.*"

Resp. 8: "*Basically say, is that aligned principles, what questions are you asking, what data do you have, what question do you want to answer with the data you have?*"

Resp. 9: **"***The quality of the question you are asking about testing the difference of means then I know some kind of mean that kind of t-test, it fits like testing some kind of correlation, association, then, some kind of chi-square test, so, though just need the questions that the line coming us have been asked effect*."

Resp. 10: **"***Yes, there is a certain information that talked about the distribution, certain information that talk about variances, certain information talk about frequencies and then you know you can actually deal with frequency or you can* *largely give the distribution of variance so it depends on which term that actually you found or something that, as some data that give you an idea that actually they are looking for frequencies then you can actually …* "

Was it difficult to decide? / Which information in the item made it difficult?

Resp. 1: **"***Humm, maybe based on limited knowledge, of some of the options that there are available, cause I have never used, for example, humm, one of the may be Kruskhal-Wallis, one way-ANOVA and I've never used that before so I have no idea what that means, so I'm told, I am told what that means, I don't know if it's applicable test. Okay.*"

Resp. 2: **"***Yaahss, it's somewhere very difficult because it is like the test you could do if for most of them and then subsequently, it then follows different statistically analysis. It became difficult on what…*"

Resp. 3: **"***Yeah, it was difficult, because those statistics, I think maybe thus, my own problem because I haven't thought I don't know each and every one, that's why may thus be mistake and also statistics is also not my kind of subject so I was struggling in that way for each one to decide.*"

"*Ok, some parameters, just by the methods, so, the methods used the one that would equal you to decide like some of them that I have no idea in answering the question and just finding difficult understanding of the data.*"

Resp. 4: **"***So most of the questions concerned hum comparisons and associations, so you look at the two items what are they interesting, so the next thing you have to do is are they qualitative or are they quantitative, so you based what test to use on the qualitative and the quantitative and then what you want to achieve.*"

Resp. 5: **"***Yeah, in terms of the scenarios it was little bit difficult but it was kind of …*"

"*At a time like a person wasn't so clear was trying to think further, think like and the amaze arises thing I think actually been looking for people because some were trying to answer so…*"

Resp. 6: **"***Yeah, it was a bit tricky because some of the stuff I haven't seen in a while.*"

"*Humm, the information that makes it difficult, I don't know the whole story behind the data just makes the selection process a bit slow, but I think that's what made it difficult people was just … the data and what you want to straight achieve and then I think that would make direct the process could be a bit quicker.*"

Resp. 7: **"***Yeah, there were times when most of the questions the required than difficult to decide or not test to choose from maybe because I have never done hummm analysis that involves such test before in my research work.*"

"*Mmmm, it is possibly because I have not thought about an analysis doing like that I can't do I don't know exactly but I note here some questions that you can't easily be like this is the kind of test you need to perform and need to humm and maybe because I have not been exposed to statistical analysis study involves such items. Possibly that is why I couldn't pick out whether I achieve it right which test is right or not.*"

Resp. 8: **"***Yeah, I found difficulty in some of them, I have been never used some of the methods, so, I haven't known where I mean, it is not everything there I know so, there are some methods there I didn't know so, then I put in up to apply then.*"

Resp. 9: **"***Yes, I mean some quizzes were easy, and some were not easy and some of the tests I have … ok them, so thing is I'm not even test so they maybe some they would have been treating to, so this test that I would have been encountered before, so I wouldn't be able to say for sure, yeah.*"

"*Some questions are dealing with understanding. Yeah, yeah. Maybe the language problem.*"

Resp. 10: **"***Yeah, I will say yes at some point, because statistics actually where it is vast, and the way we through our career as a student, we probably deal with certain considering not movement … not on certain rules of the topic, so it quite challenging but you may find other test that challenge you want to try to bring it back to which topic they belong to especially when you don't know any other topics that they can be really be part those who that look simple then you can now show actually than they took about.*"

Did alternative possibilities come to mind? / Did you think about some assumptions that you suppose to apply?

Resp. 1: **"***You mean like to fill in the gaps in my knowledge, personally?*

I do have a Bio-Stats book that I have bought to prepare it properly but only if this applies to me, in my actual research where I have been use for it. So, when I come to reading, do stats and find the appropriate test, I will apply the appropriate test, but I understand statistics so I don't need to deal with this, like, on a daily basis."

Resp. 2: **"***Yeah, in that I know like for some of these measures you need to know ehehehe the nature of the graph it is skewed or not and then decide the test. So like I wasn't have any net parameters to do that, just decided and observe is quite difficult.*"

Resp. 3: **"***First thing, thinking that you were have just think or I think I don't understand things, so I wasn't thinking like that other options, that I would put otherwise I have just writing like my own test to say I think I think so I think to the right cone because I did everything in the broad line.*"

Resp. 4: **"***Humm, not really, my concern was because reading quiet a lot of activities there almost covered everything most of the tests that could be applied so actually I didn't think outside what I have been given to because I think we over change or something alternative there.*"

Resp. 5: **"***Humm, other alternative possibilities to these tests or yes there are some ones with instead of its … like this, I think it's for the spearman and test something that it's humm a test but it's a non-parametric test that we got idea for I think is for the parameter measures related percent …*"

Resp. 6: **"***There were quite a few and there were different alternatives.*"

Resp. 7: **"***No, I didn't try too. I did not think about an alternative possibility. I am just thinking of if its either going to be one test that is suitable for a particular item or there I would know whether test that is important, suitable for it, Yaah.*"

Resp. 8: **"***Not really in a short period of time. Yeah, because some of the things that I will tell than alternatives… if you look at my responses there are some particular tests that I use for multiple number of responses and scenarios.*"

Resp. 9: "*Yes, yes.*"

Resp. 10: "*Yeah, some alternatives came, but I was not quite sure whether those items would be, would match those topics because I cannot just start pick any topics that's actually you can see the same and other black spot around I would not quite sure which what item could be it's related to what topic.*"

Why were some tests rejected?

Resp. 3: "*Some of them because humm, maybe some of them are not exactly like the options are noted exactly phrase the way like I know them, you know, maybe I know like two samples paired t-test like that but also in there, they are also make phrase different maybe for me there are also the same.*"

Resp. 5: "*I didn't go that far.*"

Resp. 6: "*I think they will be accepted.*"

Resp. 9: "*I just choose so if I read the questions and then I found that maybe two tests will be fitted so, I just choose the more relevant one according to me yeah, so I just reject the other one and pick the most relevant.*"

Resp. 10: "*Because not sure, I could not just put anything there that I have, I want to put something when I am sure.*"

How confident are you about the decision you made?

Resp. 1: "*Humm, in general, I'm very confident, pretty confident. Yes, (laugh).*"

Resp. 2: "*I would say like 80% confident.*"

Resp. 3: "*Yeah, I'm hoooo, I think some of them I was very confident. Maybe I was 60% confident.*"

Resp. 4: "*Yeah, so in which test? I'm above 80% confident.*"

Resp. 5: "*Humm partially, I even but, I haven't seen some of these things for a while. So right, I'm 60% confident.*"

Resp. 6: "*Humm, about 60 till 70% because like I could have said, I haven't seen some of this stuff in a while.*"

Resp. 7: "*Like I said, it's still a very constraint that you spend some time when you to directing something very seriously and half-way between, not too confident, but also I'm not saying I'm not confident the board of my responses.*"

Resp. 8: "*I am only confident to the respect of the target that you have been given me. Realistically telling I will put myself as C because I didn't have time to really subject each scenario, so I rate myself as C, yeah. C is 60% confident.*"

Resp. 9: "*Given that I don't know all these tests and given that I haven't done, most of these ones like undergraduate, I'm partially confident. I rate myself at 65% confident. Because the thing is like in the higher legal education we don't really use most of these tests, they allow most of in the second year so…yeah.*"

Resp. 10: "*Based on the knowledge that I had about statistics as notion of statistics, and I see how the test related to the notion that I have actually I found that I'm confident thus what I have taken as a Maths student as it comes to, I tell them that a topic that they have to be applied.*"

"*I think I will fit in the average in the sense so I didn't covered all the questions but for the things I did it's that I have covered I'm sure that I must be able to score even half of the most if I have to meet mark on only the number of questions that I have covered, I must be able to score half or maybe more than half, that's why I decided that I should have more than 50% and above.*"

Please mention any items that you are not familiar with

Resp. 1: "Humm…humm, A Fischer's z Transformation I don't know what that is. humm, a Sandler's A statistic, I don't know what those two are. Thank you."

Resp. 2: *"I have seen Fischer but I don't know what it is for. Semi-partial correlation, it sounds familiar but I don't know. Euhm, I have seen Mann-Whitney U-test but I'm not used that before, Wilcoxon signed rank test, Friedman's two-way ANOVA for ranked data I 'm not used them. MANOVA I have not used that, Discriminant analysis no, I'm not used to, these ones I have seen in literature but I'm not done them like the basic courses.*"

Resp. 3: "*The factorial ANOVA, Goodness of fit Chi-squared, t-test, Mann-Whitney, Paired t-test, Post-hoc test for comparisons I know it now then most of* *these here, like partial correlation, factor analysis, Discriminant analysis, Factor analysis, semi-partial correlation, Sandler's A statistics and path analysis.*"

Resp. 4: "*For those that I have listed here, I don't think there is any of them I'm not familiar with. I think the path analysis, Sandler's A statistics, I have been used these two before, yeah, I think I have been used these two before; but otherwise the rest I think yeah, so, the only think is you have to read the question that have been asked and try to relay them back so which is I mean need time, the time is the major problem. Because the question asked there you need to understand them first and relay them to the test that are used even you are familiar with the test, you need time to identify what test can be applied to the problem you can't just say require with this method and this problem is then I can use any method.*"

Resp. 5: "*Humm, let's see. Sandler's A statistics, Path analysis are not whether I'm thinking is not partial but what I'm thinking Fischer z transformation …* "

Resp. 6: "*Sandler's A Statistics, Path Analysis and the Mann-Whitney U- test, don't sound familiar to me at all. Yeah, there are those ones that don't sound familiar, and the Post Hoc Test for comparison of means. Humm, I have never seen that before.*"

Resp. 7: "*So for all the test that I have listed in the items, I'm not familiar with multiple correlations, and Mann-Whitney, goodness of fit, spearman's rank order correlation, humm, humm chi-square for association not too familiar with it, Humm, yahh I think there are the major ones that I'm not really familiar with. Thinkable I have done one to my daughter in-law so my work doesn't involve a lot of stats analysis just a minor and statistics or analysis that I do for stats analysis, yeah.*"

Resp. 8: "*Here, humm, here I don't know post-hoc test for what I know is that is I hardly used it. Friedmann Two-way ANOVA for rank data I don't know what that test really. Path analysis, Sandler's A statistics, I didn't know what those tests. Otherwise the rest I think, I have fair idea about what do I agree.*"

Resp. 9: "*Mann-Whitney U- test, Sandler's A statistics, path analysis, Fischer z transformation, I'm not sure, yeah, and Semi-partial correlation, Pearson's product –moment correlation, that I have haven't never seen before. Then the others, I have some ideas, yeah.*"

Resp. 10: "*There are actually so many, I'm familiar with the ANOVA thing, the ones that I'm not familiar with it's the Chi-squared test of association, the z statistics, Spearman rank order correlation, Fischer z transformation, so, there are actually so many that I'm not aware of but it seems that like Sandler's A statistics, Wilcoxon signed rank test, Discriminant analysis, Fischer z probability, like Kruskal-Wallis One-way ANOVA, it's just certain thing that I'm not aware this is my first time to hear than though I have statistics course but, there are new concepts that I really really really really fine. Thank you so much.*"

What factors hinder recovering the choice of statistical test?

Resp. 2: "*I would like to be thought you see what I mean so I know you could show me how to then observe the ways like I make up you see the data and then you decide which analysis they are declined. Because I have been following up I have done the training on literature, training on like English in terms of literature but such thing I have never seen any statistics course.*"
"Can you make time to teach if you have to ...?"

Resp. 4: "*Because the question asked, you need to understand them first then; you need time to identify what test to be applied to the problem you can't just say require this method for this problem.*"

Although scant research has been conducted on statistics learning in postgraduate studies, one way to ascertain the elements that constitute a supportive environment is to explore the specific behaviours that students rate most highly on their evaluations of choosing a right statistical test. A number of studies reveal a consistent pattern (Gal & Ginsburg, 1994; Mvududu, 2003). According to the data gathered from the participants, three main themes emerged, namely, the ability to choose a statistical test, the perceived failures to choose the right test, and non-familiar statistical tests. In order to achieve a better analysis, some of these themes were subdivided into sub-themes. Regarding the ability to choose a statistical test, three sub-themes emerged, as they highlighted major concerns about a choice of the correct statistical test, practical knowledge to choose a statistical test and confidence about the decision made. Referring to perceived failures to choose the right test, two sub-themes were established, regarding the causes of difficulty to select a statistics test, as well as the reasons of the rejection of some tests. A detailed analysis of the three themes is discussed in chapter eight.

5.4. Synthesis and partial conclusion

In this chapter, the researcher presented the results of the analyses of the determinants of SELS beliefs at UCT and the responses of the research question: How do you choose a right statistics test? The analyses were divided in two phases, namely, quantitative and qualitative. The quantitative analyses were based on three main steps: the descriptive analysis of components obtained from the quantitative questionnaire; the bivariate analysis with cross-tabulations; and the multivariate level analysis with ordinal regression models, using Logit and Cauchit link functions. These models rely on the assumed probability distributions of the continuous variables (dependent). All these steps were performed using the UCT data. In fact, the bivariate analysis focuses more on the impact of the independent variables on the SELS beliefs. The results of the bivariate analysis highlighted the STASTATS and STARS, experiences in research methodology, as well as experiences in statistics, while the effort were statistically significantly different in the means scores of SELS beliefs for the groups.

However, the multivariate level of analysis provides more statistically substantial results because of the control in the model, therefore, it is important to focus the summary on these results. The ordinal regression undertaken revealed that the independent variables predicted the level of SELS beliefs, significantly. These results constituted an important finding of this study. The outcomes of the ordinal regression, using the Logit link function was the best model, indicating that the postgraduate programmes in the engineering department, health & wellness department, as well as fear of statistics monitors, were the significant predictors of SELS beliefs. The qualitative analysis displayed a description of the participant characteristics in first part, and in the second part, the transcribed and reported results. These respondents' comments were summarised in themes and sub-themes, and the detailed discussions of these findings are presented in Chapter 8.

CHAPTER SIX

FINDINGS: THE CASE OF UWC

6.1. Introduction

In this chapter, the general results from UWC are presented in two phases. In the first phase, the quantitative results are presented, highlighting that postgraduate programmes, marital status, experiences in research methodology, as well as STARS components, were significantly different in their means scores of SELS beliefs. In addition, the ordinal regression model, using the Cauchit link function, was the best model, with a high prediction accuracy of 75.49% for all three categories. In the second phase, the qualitative findings are presented based on the participants' responses. These results indicate that error patterns were often strong among students, and their misunderstandings of concepts explained the failures observed in their selection of the appropriate tests.

6.2. Quantitative findings

Initially, a full description of the variables is provided. Thereafter, the validity and reliability of instruments are explored. In addition, the effect of independent variables on the self-efficacy to learn statistics is presented. Finally, the ordinal regression models are conducted, in order to choose the best model.

6.2.1. Descriptive Results

The information is narrative, illustrated in the form of tables and figures. In this section, the characteristics of the registered students in the postgraduate programmes (Masters, PhD and Post-doctorate) are described. The variables described comprise of background information, experiences, STARS, SATS, social support and self-efficacy.

6.2.1.1. Background information

In this current study, 51.3% of the respondents were males and 48.7% were females, indicating that there are more male postgraduate students; although, the difference in gender was minimal (2.6%). This almost contradicts the initial notion (belief) that there were more males in postgraduate studies than there are females (see Figure 6.1).

Table 6.1 Background information (UWC)

Characteristics	N	%	Characteristics	N	%
Gender			**Marital status**		
Male	80	51.3	Single	98	63.2
Female	76	48.7	Married	50	32.3
Total	156	100	Divorced	1	.6
Age group			Widow	1	.6
20-25	19	12.2	Living together	5	3.2
26-30	64	41.0	Total	155	100.0
31-40	50	32.1			
41 and +	23	14.7	***Student status***		
Total	156	100	South African	78	50.0
Ethnic groups			African	64	41.0
Black	110	70.5	Non-African	14	9.0
Coloured	35	22.4	Total	156	100.0
Indian	5	3.3			
White	6	3.8	***Post-graduate programme***		
Total	156	100	Master	94	60.3
Type of study			PhD	57	36.5
Full time	143	91.7	Post-doctorate	5	3.2
Part time	13	8.3	Total	156	100.0
Total	156	100.0			

Source: Own computation using UWC data

6.2.1.1.1. Gender of the respondents

In this current study, 51.3% of the respondents were males and 48.7% were females, indicating that there are more male postgraduate students; although, the difference in gender was minimal (2.6%). This almost contradicts the initial notion (belief) that there were more males in postgraduate studies than there are females (see Figure 6.1).

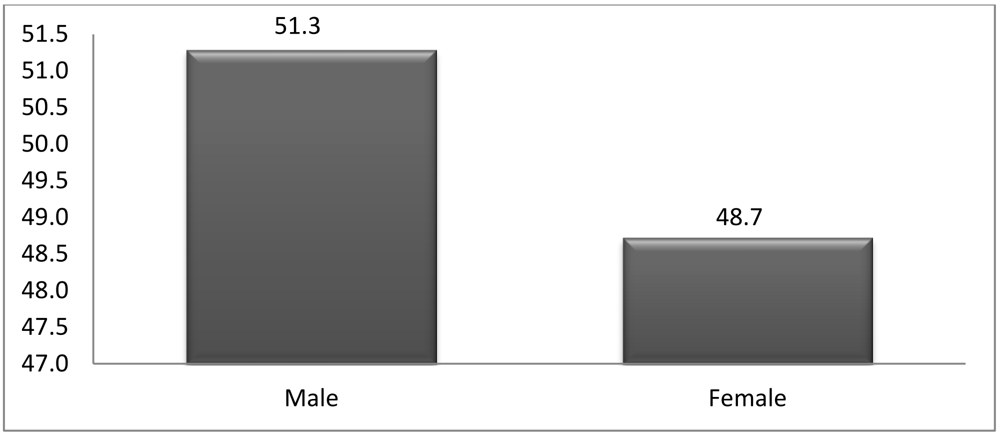


Figure 6.1: Percentage distribution of respondents' gender

Source: Own computation using UWC data

6.2.1.1.2. Age groups of respondents

The ages were categorized into four groups, namely, 20-25, 26-30, 31-40 and 41 and more. Figure 6.2 shows that there were more students between the ages of 26-30 (41%), followed by those between ages of 31-40 (32.1%), and those 41+ (14.7%), while the smallest group was between ages of 20-25 (12.2%).

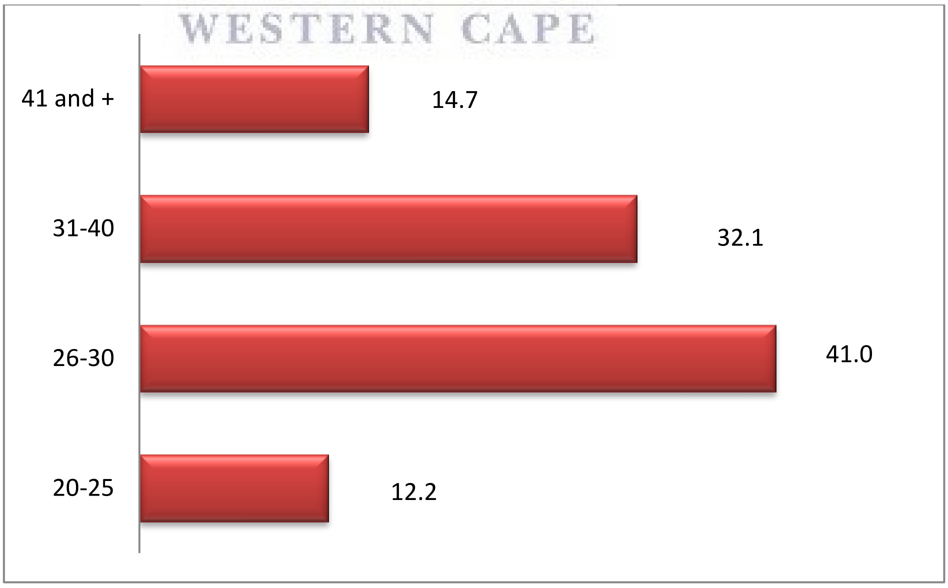


Figure 6.2: Percentage distribution of respondents' age groups

Source: Own computation using UWC data

6.2.1.1.3. Marital status

As illustrated in Figure 6.3, more than half of the students were *single* (63.2%), followed by those who were *married* (32.3%). The *widowed* and *divorced* students constituted the same score (0.6% each), while the last group was *those living together* (3.2%). Therefore, the postgraduate students were dominated by the single group.

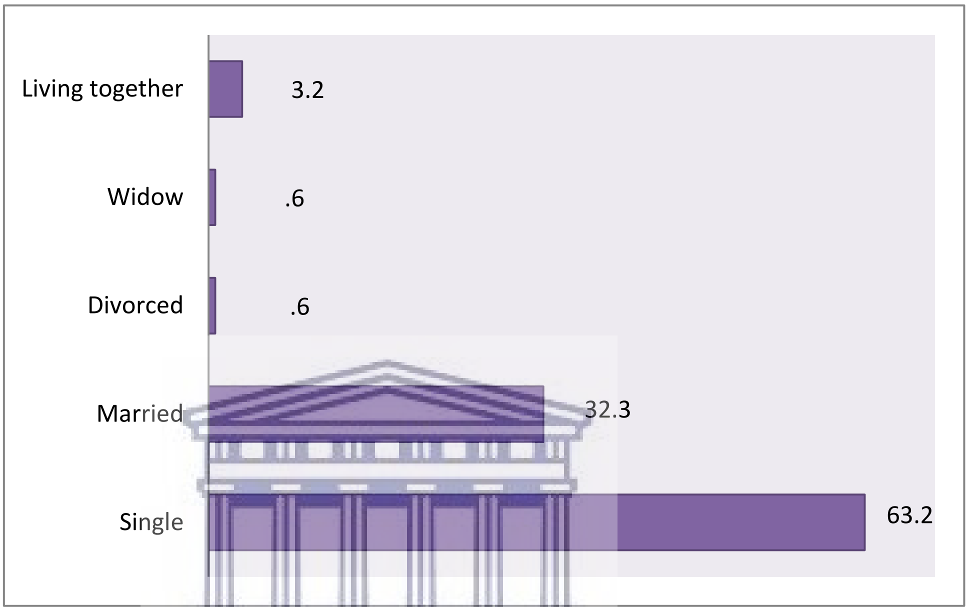


Figure 6.3: Percentage distribution of respondents' marital status

Source: Own computation using UWC data

6.2.1.1.4. Ethnic groups

UWC is situated in the Western Cape, and the sample for this current study comprised mostly of students from previously disadvantaged backgrounds and a diversity of ethnic groups (White, Indian, Asian, Coloured and Black/African). Exploring ethnic groups in this current study is of upmost importance, as it is expected that this variable will affect students' ability to learn statistics. Therefore, the ability of the students, given their specific ethnic group, was analysed in detail, using a "One-way ANOVA" method. According to Figure 6.4, the majority of students who supplied ethnic group information was Black/Africans (70.5%), followed by Coloureds (22.4%), with Whites and Indians/Asians, (3.8%) and (3.2%), respectively.

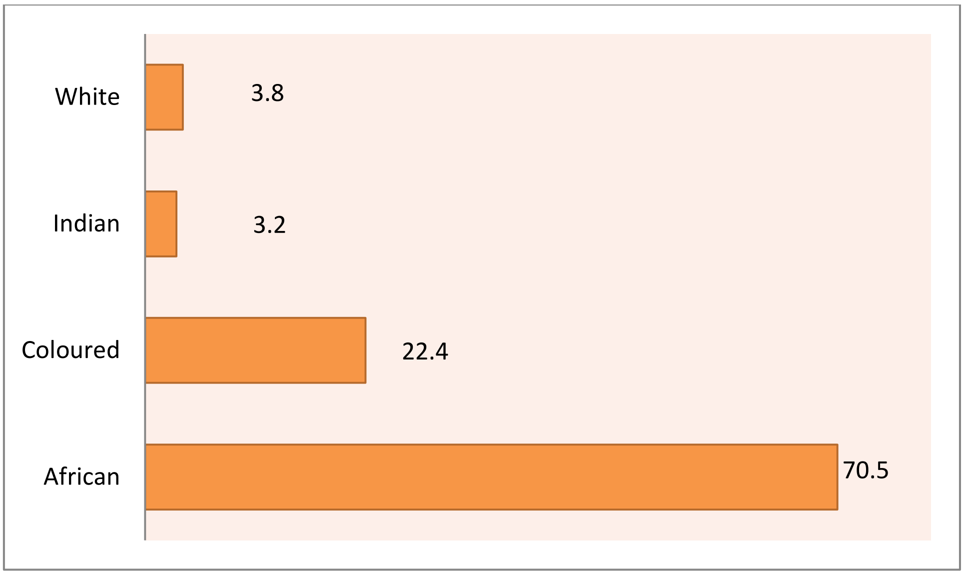
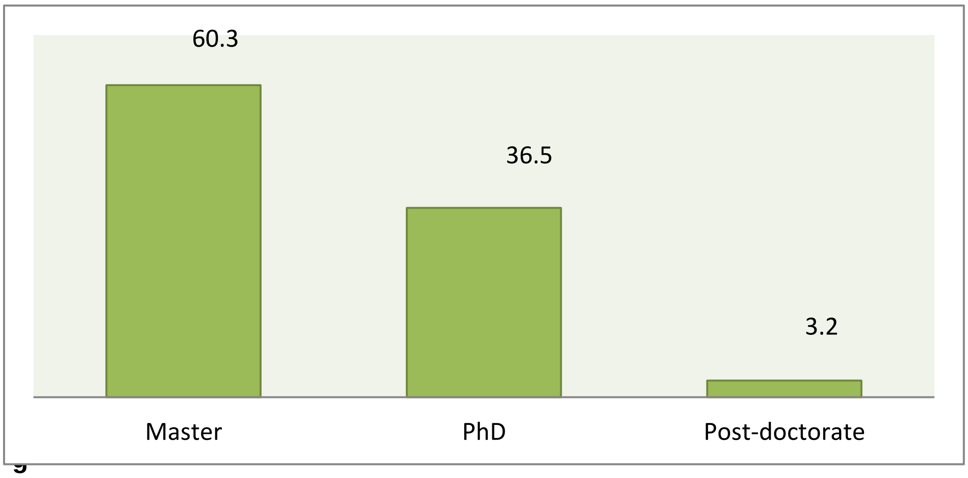


Figure 6.4: Percentage distribution of respondents' ethnic groups

Source: Own computation using UWC data

6.2.1.1.5. Postgraduate programmes

Figure 6.5 refers to the percentage of respondents' distribution across postgraduate programmes, as defined in this current study. The postgraduate programmes were categorised into three groups, namely, Master, PhD and Post-doctorate. The majority of the students were in the Master programme (60.3%), while very few were in the Post-doctorate programme (3.2%), and the rest in the PhD programme (36.5%).



gure 6.5: Percentage of respondents' distribution across postgraduate programmes

Source: Own computation using UWC data

6.2.1.1.6. Student status

Figure 6.6 displays the distribution of student status at UWC, with 50% being South African, while Non-African represented only 9% and 41% from other African countries.

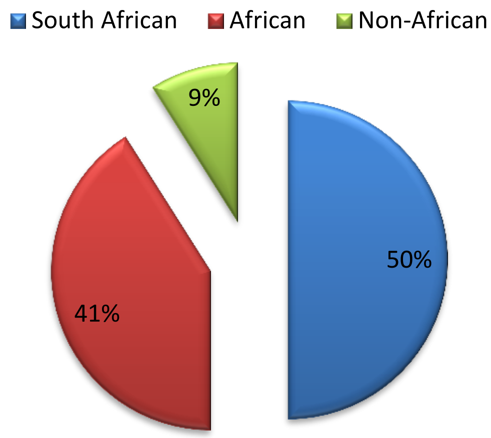


Figure 6.6: Percentage distribution of student status

Source: Own computation using UWC data

6.2.1.1.7. Type of study

Figure 6.7 illustrates that the majority of the respondents were full-time students (92%), while the remainder of the respondents were part-time postgraduate students (8%).

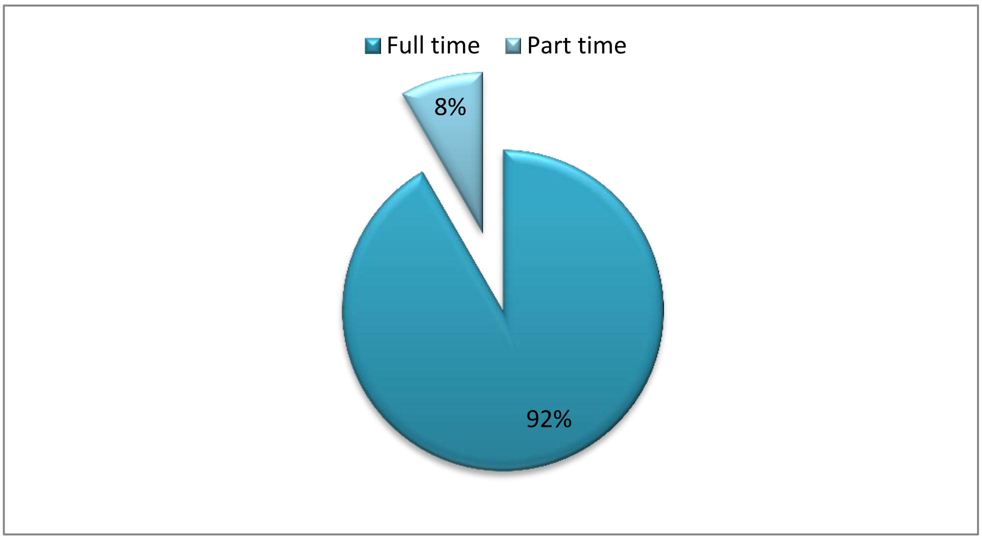


Figure 6.7 Percentage distribution of type of study

Source: Own computation using UWC data

6.2.1.2. Experiences

In this section, the quality of the experiences of the student body intake was monitored, using total scores. The report was in the form of frequencies, percentages, means and standard deviation. Table 6.2 indicates that the highest score obtained in *"experiences in research methodology"* was 88, 56.4% of the respondents, while the lowest score was 8 (5.1%). The majority of the postgraduates choose the category *good*, which represented 88 (56.4%), followed by the category *average*, with 49 (31.4%) in the same component. Regarding "*experience in statistics"*, the lowest score was 5 (3.2%) for the category *very bad*, and the highest score was for the category *average*, with 65 (41.7%). The *overall* component of experiences follows the same trend as "*experiences in statistics"*, with 10 students choosing *excellent* (6.4%). Therefore, all mean scores of the three components achieved the same category average (3).

Table 6.2: Experience components

Items	Very bad n (%)	Bad n (%)	Average n (%)	Good n (%)	Excellent n (%)	Total	Means	SD
Exp. RM	0	8(5.1)	49(31.4)	88(56.4)	11(7.1)	156	2.6	0.6
Exp. Stats	5(3.2)	17(10.9)	65(41.7)	61(39.1)	8(5.1)	156	3.3	0.8
Experiences	1(.6)	6(3.8)	56(35.9)	83(53.2)	10(6.4)	156	2.6	0.6

Source: Own computation using UWC data

6.2.1.3. STARS

An examination of the frequency distribution of the STARS scores in Table 6.3 reveals that the highest scores obtained by the respondents in "*Test and class" anxiety*, *"Interpretation of statistics"*, as well as "*Ask for help" anxiety* occurs in the same category of *moderate anxiety* with 59 (37.8%), 61 (39.1%) and 50 (32.1%), respectively, while the lowest score was also observed in the same category of *very high anxiety* with 6 (3.8%) for "*Test and class"*, 4 (2.6%) for both "*Interpretation of statistics"* and "*Ask for help" anxiety*. Regarding "*Worth of statistics"*, "*Fear of statistics"* monitor and the *Overall of* STARS, the highest score appears in the category *low anxiety* at 68 (43.6%), 62 (39.7%) and 76 (48.7%), correspondingly. Exceptionally, "*Computational self-concept"* records *no anxiety* as the highest score with 58 (37.2%). However, the lowest score is registered in the category of *very high anxiety*, which implies that few students experienced very high anxiety in all the components of STARS. The mean score of *Test and class* highlights 2.69 in the category of *moderate anxiety*, while the rest of the components of STARS achieved the mean score of the *low anxiety* category.

Table 6.3: STARS components

Component	No anx.	Low anx.	Mod. anx.	High anx.	Very high	Total	Means	SD
Test and class anxiety	15(9.6)	53(34)	59(37.8)	23(14.7)	6(3.8)	156	2.69	.968
Interpretation anxiety	22(14.1)	56(35.9)	61(39.1)	13(8.3)	4(2.6)	156	2.49	.926
Ask for help anxiety	37(23.7)	47(30.1)	50(32.1)	18(11.5)	4(2.6)	156	2.39	1.051
Worth of stats anxiety	40(25.6)	68(43.6)	33(21.2)	12(7.7)	3(1.9)	156	2.17	.963
Fear of stats monitors	47(30.1)	62(39.7)	37(23.7)	9(5.8)	1(.6)	156	2.07	.910
Computational self-concept.	58(37.2)	53(34)	32(20.5)	9(5.8)	4(2.6)	156	2.03	1.022
STARS	26(16.7)	76(48.7)	46(29.5)	7(4.5)	1(.6)	156	2.24	.804

Source: Own computation using UWC data

6.2.1.4. SATS

As illustrated in Table 6.4, the lowest scores were observed in the same category of *lowest positive attitude* for the components "*Affect"*, "*Cognitive competence"* and "v*alue"*, whereas the highest score for the same components was attained in *low positive attitude*, with 59 (37.8%), 66 (42.3%) and 75 (48.1%), respectively. Slightly different scores were achieved for the components "*Difficulty"* and the *Overall* SATS, with the highest scores in the category *moderate positive attitude* 72 (46.2%) and 89 (57.1%), and the lowest scores in a different category. Regarding "*Interest"* and "*effort"*, the lowest scores appear in the *lowest positive attitude* category, with 4 (2.6%) and 6 (3.8%), while the highest scores registered 49 (31.4%) in *high positive attitude* for "*Interest"*, and 39 (25.0%) in *higher positive attitude* for "e*ffort"*. The mean score of two components "*Interest"* and *"effort"*, in seven, was 4.9, representing a *high positive attitude*, while the mean of the rest of SATS components indicated a *moderate positive attitude*.

Table 6.4: SATS components

Component	Lowest	Lower	Low	Moderate	High	Higher	Highest	Total	Means	SD
Affect	2(1.3)	13(8.3)	59(37.8)	48(30.8)	24(15.4)	7(4.5)	3(1.9)	156	3.7	1.1
Cognitive	1(.8)	12(7.7)	66(42.3)	45(28.8)	22(14.1)	7(4.5)	3(1.9)	156	3.6	1.1
Value	2(1.3)	21(13.5)	75(48.1)	37(23.7)	14(9)	4(2.6)	3(1.9)	156	3.6	1.1
Difficulty	2(1.3)	11(7.1)	25(16)	72(46.2)	36(23.1)	8(5.1)	2(1.3)	156	4.0	1.0
Interest	4(2.6)	7(4.5)	11(7.1)	25(16)	49(31.4)	35(22.4)	25(16)	156	4.9	1.5
Effort	6(3.8)	5(3.2)	17(10.9)	21(13.5)	37(23.7)	39(25)	31(19.9)	156	4.9	1.6
SATS	0	6(3.8)	24(15.4)	89(57.1)	31(19.9)	4(2.6)	2(1.3)	156	4.1	0.8

Source: Own computation using UWC data

6.2.1.5. Social support

Table 6.5 illustrates that support from *"significant others"* and the *overall* social support achieved its highest scores, respectively, in the category *strongly agree* with 47 (30.1%) and 49 (31.4%), followed by *very strongly agree* at 37 (23.7%) for support from *"significant others"*, and 45 (28.8%) for the *overall* social support. The lowest score was 2 (1.3%), observed in *strongly disagree* for support from *"significant others"*, and *very strongly disagree* for the *overall* social support. Simultaneously, the lowest score was preceded by 3 (1.9%) in *very strongly disagree* for support from *"significant others"* and *strongly agree* for *the overall* social support.

Regarding support from *"family members"*, 1(.6%) was the lowest score in *very strongly disagree*, followed by 4 (2.6%) in *strongly disagree*, while the highest score was observed in *very strongly agree*, 57 (36.5%), followed by 37 (23.7%) in *strongly agree*.

Support from *"friends"* scored the highest in the *mildly agree* category, 41 (26.3), followed by 37 (23.7%) in *strongly agree*, while the lowest score was 3 (1.9%) in *strongly disagree*, followed by 4 (2.6%) in *very strongly disagree*. However, the support from *"family members"* presented a highest average mean score of 5.5 in the *strongly agree* category, whereas the other components' highest average mean scores were all in the same category of *strongly agree*.

Table 6.5: Social support components

Component	VSD	SDe	MD	N	MA	SA	VSA	Total	Means	SD
S. Others	3(1.9)	2(1.3)	15(9.6)	27(17.3)	25(16)	47(30.1)	37(23.7)	156	5.2	1.5
Family	1(.6)	4(2.6)	9(5.6)	22(14.1)	26(16.7)	37(23.7)	57(36.5)	156	5.5	1.4
Friends	4(2.6)	3(1.9)	11(7.1)	27(17.3)	41(26.3)	37(23.7)	33(21.2)	156	5.1	1.4
Social S.	2(1.3)	3(1.9)	12(7.7)	17(10.9)	45(28.8)	49(31.4)	28(17.9)	156	5.2	1.3

Option	Very Strongly Disagree	Strongly Disagree	Mildly Disagree	Neutral	Mildly Agree	Strongly Agree	Very strongly Agree
Abbreviation	VSD	SDe	MD	N	MA	SA	VSA

Source: Own computation using UWC data

6.2.1.6. Self-efficacy

6.2.1.6.1. Current self-efficacy

Considering the current self-efficacy (SELS) to solve and its components, Table 6.6 illustrates that for "*performance outcomes*", "*emotional arousal*" and the *overall* component of self-efficacy followed the same trend, with the highest score.

Regarding "*vicarious experiences*" and "*verbal persuasions*", the lowest score was observed in the category *no confidence at all* at 10 (6.4) and 12 (7.7), respectively, while the highest score realised was in the category *much confidence* at 42 (26.9%) for "*vicarious experiences*", and *very much confidence* at 38 (24.4%) for "*verbal persuasion*". In addition, the mean scores indicated that "*vicarious experiences*" and "*verbal persuasion*" had the highest (3.9), while the lowest was observed in *emotional arousal* (3.4). Except for "*emotional arousal*", the rest of the self-efficacy components reveal 4 as a means score.

Table 6.6: Self-efficacy to solve

Component	NCA	LC	FC	MC	VMC	CC	Total	Means	SD
Perform.	10(6.4)	25(16)	47(30.1)	30(19.2)	28(17.9)	16(10.3)	156	3.6	1.4
Vicarious	10(6.4)	17(10.9)	33(21.2)	42(26.9)	29(18.6)	25(16)	156	3.9	1.4
Verbal p.	12(7.7)	17(10.9)	33(21.2)	34(21.8)	38(24.4)	22(14.1)	156	3.9	1.5
Emotional	8(5.1)	35(22.4)	46(29.5)	33(21.2)	24(15.4)	10(6.4)	156	3.4	1.3
SELF-L	7(4.5)	26(16.7)	42(26.9)	40(25.6)	28(17.9)	13(8.3)	156	3.6	1.3

Option	No confidence at all	a little confidence	A fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using UWC data

6.2.1.6.2. Self-efficacy to learn

Regarding self-efficacy (SELS) to learn, all its components achieved the lowest score in the category *no confidence at all*, follow by *a little confidence*. "*Performance outcomes*" and the *overall* SELS indicate 48 (30.8%) and 42 (26.9%) as the highest scores in the category *very much confidence*, followed by 36 (23.1%) and 34 (21.8%), respectively, in the category *complete confidence*. "*Vicarious experiences*" and "*verbal persuasions*" attained their highest score in the category *complete confidence* at 41 (26.3%) and 44 (28.2%), respectively. All the components presented the same means scores (4, because they were all less than 4.5).

Table 6.7: Self-efficacy to learn

Component	NCA	LC	FC	MC	VMC	CC	Total	Means	SD
Perform.	6(3.8)	15(9.6)	21(13.5)	30(19.2)	48(30.8)	36(23.1)	156	4.3	1.4
Vicarious	5(3.2)	8(5.1)	30(19.2)	37(23.7)	35(22.4)	41(26.3)	156	4.4	1.4
Verbal p.	6(3.8)	13(8.3)	22(14.1)	31(19.9)	40(25.6)	44(28.2)	156	4.4	1.4
Emotional	5(3.2)	16(10.3)	31(19.9)	36(23.1)	38(24.4)	30(19.2)	156	4.1	1.4
SELF-L	4(2.6)	14(9)	30(19.2)	32(20.5)	42(26.9)	34(21.8)	156	4.3	1.4

Option	No confidence at all	Little confidence	Fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using UWC data

6.2.1.6.3: Assessment scores for self-efficacy to learn statistics

Self-efficacy to learn statistics (SELS) instruments were designed to measure the students' ability to understand real world problems and procedural knowledge about concepts, such as SELS. The absolute difference between the SELS to solve, and the SELS to learn, represents the ability to learn statistics, or (SELS) beliefs. In general, students scored *much confidence* as the average in all the components of self-efficacy (Mean = 4, see Table 6.6), while they improve their score slightly, which did not considerably affect any change of category (Mean = 4, see Table 6.7). In addition, Table 6.8 presents information from 156 respondents, ranging in SELS from 1 to 3, with a mean score of 1.63 and standard deviation of .719. The positive skewness value (.676) indicates a slight positive skew (scores clustered to the left at the low values). Negative kurtosis (-.797) designates a scattering that is moderately uniform (too many cases in the extremes). This skewness would not make a meaningful change in the investigation (Tabachnick & Fidell, 2007), because of the size of sample.

Table 6.8: Distribution current responses SELS

N	**Valid**	**156**
	Missing	**0**
Mean		1.63
Std. Deviation		.719
Skewness		.676
Std. Error of Skewness		.194
Kurtosis		-.797
Std. Error of Kurtosis		.386
Minimum		1
Maximum		3

6.2.2. Reliability of the Scales for UWC

The data were entered into the software package for statistical analysis, SPSS version 24 (IBM, 2010). After the preliminary descriptive analysis, namely, the means, standard deviations, frequencies were completed; the internal consistency reliability analyses, for example, Cronbach's alpha test, was conducted. The reliability coefficients for each of the five factors are illustrated in Table 7.9, which are relatively consistent with estimates observed in prior studies.

The validity evidence of current self-efficacy to other variables was recorded. Retrieved from Table 7.9 in section 7.3, its essential consistency reliability was described as .961 Cronbach's Alpha. In addition, its reliability for SELS beliefs was reported as .980. Regarding the *experiences* component, the indication of rationality experiences to other variables was denoted. The consistency for each of the components ranged between .758 and .816, with "*experiences in statistics",* .758, "*experiences in research methodology",* .816, and the reliability of *overall* experiences, .820. Concerning the STARS instrument, the dependability for each of the components fluctuated from .795 to .962, with "*worth of statistics",* .937; "*interpretation anxiety",* .912; "*test and class anxiety",* .901; "*computational self-concept",* .888; "*fear of asking for help" peers*, .798; and "*fear of asking help" monitors,* .795. The rationality indication of STARS to other variables was stated.

According to the independent variable attitudes, it was described to have strong coexisting rationality with the SATS instrument. Each of subscales was displayed as reliable with Cronbach's Alpha at .661 for *"affect",* .613 for *"cognitive competence"*, .711 for "*value"*, .707 for *"difficulty"*, .884 for *"interest"* and .904 for *"effort"* (Wise, 1985). The Cronbach's Alpha coefficient reported reliable as .876 for the SATS.

For the independent variable of social support, the MSPSS (Zimet *et al.*, 1990) was applied. Three subscales, namely, support from *"significant others"*, .837, support from *"family members"*, .883, and support from "*friends*", .875 were achieved. The instrument was considered as reliable with Cronbach's Alpha coefficients reported as .929 for the social support.

6.2.3. Impact of Independent Variables on SELS Beliefs

This section assesses some comparisons using the "Independent samples t-test", as well as "One-way ANOVA test" to measure the influence of independent variables on the self-efficacy to learn statistics.

6.2.3.1. Impact of background information on SELS Beliefs

Regarding background information, two variables (postgraduate programme and marital status) indicated significant differences between their mean scores during the t-test to compare their groups. However, an "independent-samples t-test" was directed to determine if there were variantions in the means of the SELS beliefs scores among the masters and PhD/post-doctorate students. The inspection of the variables, using a boxplot, indicated no outliers in the data. The SELS beliefs scores for each level of postgraduate programme were normally distributed, as assessed by Kolmogorov-Smirnov test ($p > .05$). The results displayed in this section are retrieved from Tables 6.9a,b below. The implication level of Levene's test was $p = .000$, this means that the variances for the two groups are not the same, so the Welch-Satterthwaite correction was tangible (second line of the t-test table is used). There was a statistically substantial difference between the mean of the self-efficacy test scores for the masters students ($M = 1.128$, $SD = .923$) and for the PhD/post-doctorate students ($M = .626$, $SD = .584$); $t(154) = 4.152$, $p = .000$, two-tailed. Mean difference = .501, 95% CI: [.262 to .739], two-tailed. The differences in means was moderate (eta squared = .10).

An "independent-samples t-test" was led to find out if there was a noteworthy modification in means SELS ratings between single/divorced/widows and married/cohabiting students. Given that the Levene's test for equality of variances was $p = .884$, which was greater to .05, the first line as seen in the Table Independent samples test should be applied, so equal variances assumed. No distortions were found in the data. Results confirmed that single/divorced/widows were more elaborate in performance outcomes compared to married/cohabiting students. There was a statistically substantial difference in means scores for single/divorced/widows students ($M = 1.036$, $SD = .791$) and married/cohabiting students ($M = .693$, $SD =.780$). The mean difference = .342, 95% CI: [.072 to

.613], t (146) = 2.502, p = .013, two-tailed. Despite the significant difference in means, the difference was small (eta squared = .04), which implied that little variance in performance outcomes was explained by marital status.

Table 6.9a: Group statistics

Academic and demographic variables		N	Mean	Std. Deviation	Std. Error Mean
SELS	Master	94	1.128	.923	.095
	PhD and Post-doc	62	0.626	.584	.074
	Single	98	1.036	.791	.080
	Married	50	0.693	.780	.110
	Male	80	0.950	.781	.087
	Female	76	0.906	.904	.104
	Full time	143	0.720	.810	.068
	Part time	13	0.779	1.154	.320

Futhermore, an "independent-samples t-test" was lead to match the SELS scores for men and women. There was no considerable difference in ratings for men (M = .727, SD = .781) and women (M = .724, SD = .903); t (154) = .025, p = .980 (two-tailed). The greatness of the difference in the means (mean difference = .003, 95% CI: -.263 to .269) was very very slight (eta squared = .000004). The groups were relatively the same.

Moreover, a similar test was done for the type of study, using "an independent-samples t-test" to investigate whether there was an important change between full-time and part-time students, which appears under t-test for equivalence of means. The results indicated that there was no main difference in ratings for full-time (M = .720, SD = .810) and part-time students (M = .779, SD = 1.145); t (154) = -.243, p = .809, two-tailed. The degree of the difference in the means (mean difference = -.059, 95% CI: -.541 to .423) was very small (eta squared = .0003).

Table 6.9b: Independent samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
SELS Mean - postgraduate programmes	Equal variances assumed	13.305	.000	3.801	154	.000	.501	.132	.241	.762
	Equal variances not assumed			4.152	153.786	.000	.501	.121	.263	.740
SELS Mean - Marital status	Equal variances assumed	.249	.618	2.502	146	.013	.342	.137	.072	.613
	Equal variances not assumed			2.514	99.995	.014	.342	.136	.072	.613
SELS Mean - Gender	Equal variances assumed	.000	.993	.328	154	.743	.044	.135	-.222	.311
	Equal variances not assumed			.327	148.289	.744	.044	.136	-.224	.312
SELS Mean - Type of study	Equal variances assumed	1.075	.301	-.243	154	.809	-.059	.244	-.541	.423
	Equal variances not assumed			-.181	13.097	.859	-.059	.327	-.766	.647

This second sub-section deals with comparisons, using a "One-way ANOVA test" (see Table 6.9c,d). For background information, three variables (age group, ethnic group and student status) emerged with more than two groups. A "One-way ANOVA test" was directed to investigate the influence of age on levels of SELS beliefs. The participants were divided into four categories rendering to their age (group 1: 20-25yrs; group 2: 26 to 30yrs; group 3: 31 to 40yrs; group 4: 41yrs and above). The Levene's test of homogeneity revealed no violation of assumption of equal variances ($p = .174$). The results indicated no statistically important difference at the $p < .05$ level in SELS ratings for the four age groups: $F (3, 152) = 1.561$, $p = .201$.

Similarly, the "One-way ANOVA test" was lead to investigate the impact of ethnic group on levels of SELS beliefs. Postgraduate students were separated into four sets based on their ethnic (set 1: African; set 2: Coloured; set 3: Indian; set 4: White). The significance value for Levene's test was p = .818, better than .05, representing no violation supposition of variances consistency. The outcomes demonstrated no major modification at the $p < .05$ level in SELS beliefs' scores for the three age groups: F (3, 152) = .452, p = .716. The present difference in mean scores between the groups signified nothing, closed to zero. However, the influence size, planned using eta squared, was .008.

Table 6.9c: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Age group	1.679	3	152	.174
Ethnic group	.311	3	152	.818
Student status	.114	2	153	.892

A "One-way ANOVA test" was engaged to examine the influence of student status on levels of SELS beliefs. Respondents were splitted up into three groups according to their student status (group 1: South African; group 2: African; group 3: Non-African). The homogeneity of variance, Levene's test p = .892 revealed that the variance in scores was likely the same for each of the three groups. There was no statistically significant difference at the $p < .05$ level in SELS beliefs' scores for the three age groups: F (2, 153) = .712, p = .492. The weight size, calculated using eta squared, was .009.

Table 6.9d ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Age group	Between Groups	3.273	3	1.091	1.561	.201
	Within Groups	106.219	152	.699		
	Total	109.492	155			
Ethnic group	Between Groups	.969	3	.323	.452	.716
	Within Groups	108.523	152	.714		
	Total	109.492	155			
Student status	Between Groups	1.010	2	.505	.712	.492
	Within Groups	108.482	153	.709		
	Total	109.492	155			

6.2.3.2. Impact of STARS on SELS

As mentioned in the overview of section 5.2.3, Experiences included experience in research methodology, experiences in statistics and overall experiences. STARS had three components (SITSTATS, STASTATS and overall STARS). SATS factors comprised "affect", "cognitive competence", *"value"*, *"difficulty"*. *"interest"*, *"effort"* and *overall* SATS. Social support factors involved support from *"significant others"*, *"family members", "friends"* and *overall* support. Each group represented an independent random sample. Each group is obtained by taking samples from each department or sub-group of a population (university) and within each group selecting sites using a simple random sample. The scattering of the responses followed a normal distribution. The population variances were equal across responses for the group levels. This was evaluated by applying a rule of thumb that, if the main sample standard deviation, divided by the smallest sample standard deviation, was not greater than two, it is assumed that the population variances were equal. In addition, the size of each group is at least 15. No outliers were found in the data and the results are presented in Tables 6.10a and 6.10b below.

Table 6.10a: Group statistics

STARS			N	Mean	Std. Deviation	Std. Error Mean
SELS	SITSTATS	Low anxiety	78	4.64	1.279	.145
		Moderate & High anxiety	78	3.87	1.352	.153
	STASTATS	Low anxiety	112	4.43	1.271	.120
		Moderate & High anxiety	44	3.82	1.514	.228
	STARS	Low anxiety	99	4.49	1.240	.125
		Moderate & High anxiety	57	3.84	1.486	.197

The STARS was revised into three factors, namely, SITSTATS, STASTATS and the overall STARS, gathered into two categories: low anxiety and moderate/high anxiety. An "Independent Samples t-test" was examined to identify if there were differences in the means scores of SELS beliefs, according to SITSTATS groups.

The analytical test found that there was a statistically substantial difference in means ratingss for low anxiety students (M = 4.640, SD = 1.279) and moderate/high anxiety students (M = 3.870, SD = 1.352); t (2, 154) = 3.651, p = .000, two tailed. The degree of the change in the means (mean difference = .769, 95% CI: [-.353 to 1.185] was a reasonable influence (eta squared = .08).

Table 6.10b Independent samples test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
SELS Mean - SITSTATS	Equal variances assumed	.208	.649	3.651	154	.000	.769	.211	.353	1.185
	Equal variances not assumed			3.651	153.529	.000	.769	.211	.353	1.186
SELS Mean - STASTATS	Equal variances assumed	1.616	.206	2.554	154	.012	.610	.239	.138	1.083
	Equal variances not assumed			2.367	68.106	.021	.610	.258	.096	1.125
SELS Mean - STARS	Equal variances assumed	.086	.770	3.615	149	.000	.828	.229	.375	1.280
	Equal variances not assumed			3.516	39.053	.001	.828	.235	.352	1.304

Regarding STASTATS, the same "independent Samples t-test" was done and the findings revealed that there was a statistically important modification in the scores for students with low anxiety (M = 4.430, SD = 1.271) and students with moderate/high anxiety (M = 3.820, SD = 1.514); t (154) = 2.554, p = .012, two-tailed. The greatness of the change in the means (Variation = .610, 95% CI: [.138 to 1.083] was a minor effect (eta squared = .04).

Additionally, using an "independent samples t-test", the overall STARS presented similar results, as there was a statistically significant difference in means ratings for low anxiety students (M = 4.490; SD = 1.240) and moderate/high students (M = 3.840; SD = 1.486); t (154) = 2.942, p = .004, two tailed. The size of the variance in the means (mean difference = .653, 95% CI: [.214 to 1.091] was a small effect (eta squared = .05), although SITSTATS, STASTATS and overall STARS components revealed that there were statistically significant differences in means scores for its groups.

6.2.3.3. Experiences differences

All results of this section are illustrated in Tables 6.11a,b,c,d below. For the effect of experiences on SELS, a one-way ANOVA was led for each component. The results of the association experiences in research methodology and SELS beliefs indicated that a statistically meaningful change was found at the $p < .05$ level in self-efficacy ratings for the three experience groups: F (2, 148) = 3.317, p = .039. Given that the Levene test of homogeneity of variances indicated p = .003 (violation of assumption), the alternative, derived from robust tests of equality of means, showing Welch (p = .109) and Brown-Forsythe (p = .134), were considered. Notwithstanding the accomplishment of statistical meaning, the current variation in mean ratings among the groups was fairly small. The effect size, designed using eta squared, was minor (.04). Multiple appraisals, using the Tukey HSD test, showed that the mean rating for only Group 2 (M = 1.174, SD = 1.045) was meaningfully different from Group 3 (M = .802, SD = .671). Group 1 (M = .989, SD = 1.097) did not differ meaningfully from either Group 2 or 3.

Table 6.11a: Test homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Exp.Rmeth	5.879	2	153	.003
Exp stats	.189	2	153	.828
Experience	6.543	2	153	.002

Table 6.11b: Robust tests of equality of means

		Statistic*	df1	df2	Sig.
Exp Rmeth	Welch		Statistic*	df1	df2
	Brown-Forsythe	2.212	2	21.291	.134
Experience	Welch	1.048	2	15.298	.374
	Brown-Forsythe	.651	2	12.390	.539

* Asymptotically F distributed.

In addition, a "One-way ANOVA test" was conducted to examine the impact of experiences in statistics on levels of the students' ability to learn, as measured by the SELS. The respondents were organised into three groups, as in the previous paragraph. There was no major variance at the p = .587 level in SELS ratings for the three experience in statistics groups: F (2, 153) = .534, p = .587. Despite no significance difference in the means scores for experiences in statistics, the Levene's test of homogeneity of variances revealed no destruction of the hypothesis, with p = .828.

Table 6.11c: ANOVA experiences

		Sum of Squares	df	Mean Square	F	Sig.
Experience Rmeth	Between Groups	4.550	2	2.275	3.317	.039
	Within Groups	104.943	153	.686		
	Total	109.492	155			
Experience statistics	Between Groups	.760	2	.380	.534	.587
	Within Groups	108.733	153	.711		
	Total	109.492	155			
Experiences	Between Groups	1.744	2	.872	1.238	.293
	Within Groups	107.748	153	.704		
	Total	109.492	155			

Furthermore, a similar "One-way ANOVA test" was engaged to scrutinise the stimulus of overall experiences on the levels of the students' ability to learn, as measured by the SELS beliefs. The Levene statistics test revealed p = .002, indicating a violation of assumption of homogeneity. Subsequently, robust tests of equality of means provided two alternatives, Welch (p = .374) and Brown-Forsythe (p = .539), to apply.

The results of the association of overall experiences and SELS indicated that there was no heavy dissimilarity at the p > .05 level in self-efficacy scores for the three overall experience groups: F (2, 153) = 1.238, p = .293. The overall experiences could not explain the change observed in SELS. However, experiences in statistics and the overall experiences did not provide statistically significant results.

Table 6.11d: Multiple comparisons

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
ExpRmeth	Tukey HSD	Bad	Average	-.18389	.31581	.830	-.9313	.5636
			Good	.18739	.30441	.812	-.5331	.9079
		Average	Bad	.18389	.31581	.830	-.5636	.9313
			Good	.37128	.14466	.030	.0289	.7137
		Good	Bad	-.18739	.30441	.812	-.9079	.5331
			Average	-.37128*	.14466	.030	-.7137	-.0289
Expstats	Tukey HSD	Bad	Average	-.16177	.20793	.717	-.6539	.3304
			Good	-.02833	.20640	.990	-.5168	.4602
		Average	Bad	.16177	.20793	.717	-.3304	.6539
			Good	.13344	.14572	.631	-.2114	.4783
		Good	Bad	.02833	.20640	.990	-.4602	.5168
			Average	-.13344	.14572	.631	-.4783	.2114
Experience	Tukey HSD	Bad	Average	-.07589	.33642	.972	-.8721	.7203
			Good	.14580	.32890	.897	-.6326	.9242
		Average	Bad	.07589	.33642	.972	-.7203	.8721
			Good	.22169	.14194	.265	-.1143	.5576
		Good	Bad	-.14580	.32890	.897	-.9242	.6326
			Average	-.22169	.14194	.265	-.5576	.1143

6.2.3.4. SATS differences

SATS comprised seven components as follows: "*effort*", "*affect*", "*cognitive competence*", "*value*", "*difficulty*", "*interest*" and the *overall SATS*, categorized into three groups (group 1 = low positive attitude; group 2 = moderate positive attitude and group 3 = high positive attitude). These results are summarised in Tables 6.12a,b below. Regarding "*effort*", a "One-way ANOVA test" was applied to examine the influence of effort on the SELS beliefs scores. The Levene's test of homogeneity of variances exposed no destruction of assumption (p= .455). In addition, the findings discovered no statistically significant difference in means. Therefore, F (2, 153) = .413, p = .662, with the effect size .005.

Table 6.12a: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Affect	.213	2	153	.808
Cog comp	1.361	2	153	.259
Value	.232	2	153	.793
Difficulty	.050	2	153	.952
Interest	.737	2	153	.480
Effort	.791	2	153	.455
SATS	.082	2	153	.921

The results contained in Table 6.12b identified no statistically important main effect for the "*affect*" attitude, with admiration to SELS, F (2, 153) = .414, p = .661; the test of homogeneity of variances presented p = .808, no violation of assumption. In addition, the results indicated that the mean level of SELS beliefs was higher among the moderate and higher attitude students (group 2 = .972, group 3 = 1.005).

For "*cognitive competence*", the findings also revealed no statistically significant effects on the SELS subscale, F (2, 153) = 2.408, p = .093, with the test of homogeneity of variances at p = .259, greater than .05, revealed equal variances assumed.

Concerning "*value*", a "One-way ANOVA test" revealed no statistically substantial effect on the SELS, F (2, 153) = .252, p = .777, with a statistics test of p = .793 (no violation of assumption of homogeneity of variances). Therefore, a similar "One-way ANOVA test" was competed for the "*difficulty*" factor to inspect its main impact on SELS beliefs scores. The findings indicated no meaningful difference at p = .933. F (2, 153) = .069, P = .933 with test of homogeneity of variances p = .952 showing no violation of assumption.

Table 6.12b: SATS ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Affect	Between Groups	.590	2	.295	.414	.661
	Within Groups	108.902	153	.712		
	Total	109.492	155			
Cog comp	Between Groups	3.342	2	1.671	2.408	.093
	Within Groups	106.151	153	.694		
	Total	109.492	155			
Value	Between Groups	.360	2	.180	.252	.777
	Within Groups	109.132	153	.713		
	Total	109.492	155			
Difficulty	Between Groups	.099	2	.049	.069	.933
	Within Groups	109.394	153	.715		
	Total	109.492	155			
Interest	Between Groups	.383	2	.191	.268	.765
	Within Groups	109.109	153	.713		
	Total	109.492	155			
Effort	Between Groups	.588	2	.294	.413	.662
	Within Groups	108.905	153	.712		
	Total	109.492	155			
SATS	Between Groups	.244	2	.122	.171	.843
	Within Groups	109.248	153	.714		
	Total	109.492	155			

For the "*interest"* factor, no statistically weighty modification in means scores SELS, F (2, 153) = .268, p = .765 was illustrated in Table 6.12b, with the Levene statistics test of p = .480 indicating no violation of the statement of similarity of variances. In addition, the "One-way ANOVA test" outcomes for the *overall SATS* association with SELS scores revealed no important difference in means ratings, F (2, 153) = .171, p = .843 with test of homogeneity of variances showing p = .921 (no violation of the assumption in Table 6.12a).

6.2.3.5. Social support differences

Social support was divided into four factors, namely, support *from "significant others", "family members", "friends"* and the *overall* social support. Each of factors was categorized into three groups, namely, disagree, neutral and agree. Tables 6.13a,b below show the summary of its results.

Concerning the support from *"significant others"*, a "One-way ANOVA test" was performed to check the effect of the support from "significant others" on the levels of SELS scores. Table 6.13b revealed that there was no statistically important modification in means SELS beliefs scores, F (2, 153) = .460, p = .632, with the Levene's test at p= .177, indicating no violation of assumption homogeneity of variances.

Table 6.13a: Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
SIG. O.	1.750	2	153	.177
Family members	.693	2	153	.501
Friends	1.209	2	153	.301
Social support	2.858	2	153	.060

Regarding support from *"family members"*, analogous analysis using a "One-way ANOVA test" was done to identify the bearing of family support on different levels SELS scores. The findings indicated that there was no statistically weighty variance in means SELS beliefs scores associated to "family members" support, F (2, 153) = .061, p = .941 with test of homogeneity of variances p = .501 revealing no violation of assumption.

As far as support from *"friends"* is concerned, a "One-way ANOVA test" was achieved to determine the control of the support from "friends" on different levels of SELS scores. Although the results showed that there was no statistically noteworthy difference in means SELS beliefs ratings, F (2, 153) = 1.195, p = .305 with the Levene's test p = .301 > .05 revealing no violation of assumption.

Table 6.13b: Social support ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
SIG. O.	Between Groups	.654	2	.327	.460	.632
	Within Groups	108.838	153	.711		
	Total	109.492	155			
Family	Between Groups	.087	2	.044	.061	.941
	Within Groups	109.405	153	.715		
	Total	109.492	155			
Friends	Between Groups	1.684	2	.842	1.195	.305
	Within Groups	107.808	153	.705		
	Total	109.492	155			
Social support	Between Groups	1.003	2	.502	.707	.495
	Within Groups	108.489	153	.709		
	Total	109.492	155			

Definitely, the *overall* social support also applied a "One-way ANOVA test" in detecting a difference among groups on the level of SELS scores. Therefore, the results exposed no statistically significant difference in SELS means, F (2, 153) = .707, p = .495 with the Levene's statistics test p = .060 > .05 indicated no violation of assumption of homogeneity of variances. However, none of the social support component exhibited a statistically significant difference in means score, when determining the impact of these variables on SELS, using a "One-way ANOVA test".

6.2.4. Multivariate Analysis UWC

Building an ordinal regression model for students' ability to apply statistical procedures at UWC involves several assessments. There is a need to observe the dispersal of values for the outcome variable. Still, it is not flawless whether the ordinal outcome is equally spaced. The histogram for the dependent variables shows the distribution of categories of the overall students' self-efficacy to learn statistics (Harpe, 2015). The ordinal regression analysis uses a link function to designate the effect of the explanatory variables on ordered categorical outcome, in such a way that the assumptions of normality and constant variance are not required (McCullagh & Nelder, 1989). The choice of the link function provides a good fit for the data. Figure 6.8 reveals that the data have many extremes values. Therefore, the Cauchit link function was applied, since that function focused on the outcome with many extreme values. The model assumes that the relationship between the explanatory variables and the ordinal outcome is self-regulating of the category, because the regression coefficient does not depend on the categories of the outcome variable. Essentially, the model assumes that the consistent regression coefficients in the link function are equal for each cut-off point (Bender and Benner, 2000).

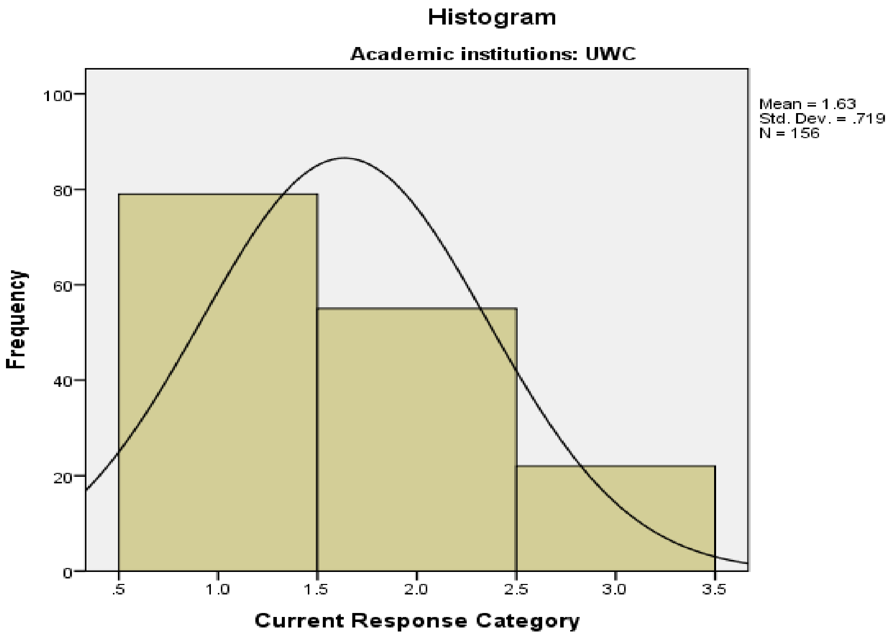


Figure 6.8: Distribution of the overall students' self-efficacy to learn statistics at UWC

6.2.4.1. Predictive value of the model

The model provides suitable predictions. While the log-likelihood statistics are unsure, due to the large number of empty cells in the model, the difference between the two log-likelihoods can usually still be interpreted as chi-square distributed statistics (Elamir & Sadeq, 2010). Therefore, the model fitting information indicated a significant chi-square statistic, which implied a significant improvement over the baseline intercept-only model, with $p < .001$ (Table 6.14). This indicated that the model provided better predictions than deductions, based on the low probabilities for the outcome categories.

Table 6.14: Model-fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	298.267			
Final	239.714	58.553	29	.001

Link function: Cauchit

6.2.4.2. Test of parallel lines

The subsequent test assessed the assumption that the parameters (slope coefficients) were the same for all response categories. The general model (with separate parameters for each category) revealed a significant improvement in the model fit. The observed significance level in Table 6.15 was large (p= .546), as there was no sufficient evidence to reject the parallelism hypothesis. It is also possible that the poor model fit was due to the chosen ordering of the categories of the dependent variable. An ordering that places "little confidence" as a greater value, may have had a better fit.

Table 6.15: Test of parallel lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	239.714			
General	212.233[b]	27.481[c]	29	.546

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Cauchit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

6.2.4.3. Pseudo R-squared measures

Three pseudo R-squared values are illustrated in Table 6.16. All of the pseudo R-squared values indicated that this model fitted the outcome data. In this case, the higher pseudo R-squared value indicates the best model to guess the effect. According to this measure, Nagelkerke/Cragg & Uhler's was the best at 37%, followed by Cox & Snell's with 32%, and McFadden (20%) was the worst (Cohen *et al.*, 2013; Smith & McKenna, 2013). Cox & Snell's pseudo R-squared value had a maximum value that was less than one. If the full model perfectly predicted the outcome, and had a likelihood of 1, Nagelkerke/Cragg & Uhler's R-squared value = 1.

Table 6.16: Pseudo R-squared measures

Cox & Snell	.321
Nagelkerke/Cragg & Uhler	.373
McFadden	.196

Link function: Cauchit

6.2.4.4. Classification table

The inspection of the predictions generated by the model, is summarized in Table 6.17. Based on the predicting cumulative probabilities, the model could produce correct predicted categories, based on the values of the predictor variables. A classification table, or a confusion matrix, represents the cross-tabulation of the predicted categories, with the actual categories.

Table 6.17: Confusion matrix for the initial model

Current response Categories		**Predicted Response Categories**			**Total**
		A little confidence	**A fair amount of confidence**	**Much confidence**	
A little confidence	n	60	11	5	76
	% within Current Response Category	78.80%	14.50%	6.60%	100.00%
A fair amount of confidence	n	6	47	1	
	% within Current Response Category	11.10%	87.00%	1.90%	100.00%
Much confidence	n	8	6	7	
	% within Current Response Category	38.10%	28.60%	33.30%	100.00%
Total	N	74	64	13	
	% within Current Response Category	49.00%	42.40%	8.60%	100.00%

Link function: Cauchit

The model seemed to be doing an adequate job of predicting outcome categories, at least for the most frequent categories - category 2 (a fair amount of confidence) and category 1 (little confidence). The model correctly classified 87.0% of the category 2 cases, and 78.8% of the category 1 cases. However, the respondents in the 2 categories were more likely to be classified as category 1, than category 2, a desirable result for predicting ordinal responses. In addition, category 3 (much confidence) respondents were somewhat poorly predicted, with the majority of cases being assigned to category 1 (little confidence), a category that should, theoretically, be most dissimilar to category 1, which might have indicated a problem in the way the ordinal outcome scale was defined.

Although this issue will not be discussed any further at this point, in an actual data analysis situation, it probably would be necessary to investigate whether the ordinal scale could be improved by reordering, merging, splitting or excluding some categories. However, the model confirmed high prediction accuracy (75.49%) for all three categories combined.

6.2.4.5. Interpreting the model

The effect of each predictor is summarised in Table 6.18. The nature of the link function, the signs of the coefficients for covariates, and the relative values of the coefficients for factor levels, provide important information concerning the effects of the predictors in the model. After applying the complete model with the Cauchit link, only one threshold of the model equation was significantly different from zero, and considerably contributed to the values of the response probability in different categories, as illustrated in Table 6.18. In addition, subsequent interpretations, based on the parameter estimates are followed. A total of 6 factors *(ask for help, worth of statistics*, *fear of statistics teachers*, *affect*, *cognitive competence* and *support from significant others*) and 3 covariates (*marital status, ethnic groups* and *type of study*) were found to be significantly associated with the self-efficacy to learn statistics. These predictors performed very well in the model. Among them, *worth of statistics, cognitive competence* and *type of study* had negative coefficient estimates.

"Ask for help" achieves very well in the model. The implication of the assessment for this factor is fewer than 0.05 (p= .010), signifying that its experiential consequence is not accidental. Meanwhile its coefficient is positive,

as "*ask for help"* upsurges, so does the likelihood of being in one of the upper classes of explanation status.

In addition, "*fear of statistics"* teacher was an important predictor of SELS beliefs. The respondents with low and moderate anxiety are more probably to be in the lower result categories, than those with high. The significance level of the test for "*fear of statistics" teacher* is .023, less than 0.05, telling that its practical outcome is not in line for an unintended event.

Regarding the "*affect"* factor, it is presented as one of good prognosticator of SELS beliefs in Table 6.18. The meaning level of the test for affect is p= .008, less than 0.05, revealing that the "*affect"* factor amply explains the change observed on the dependent variable. Therefore, with a positive coefficient, as "*affect"* rises, so does the likelihood of recording one of the higher cumulative outcome groups.

Support from *"significant others"* substantially contributes to the model. Students with *very strongly, strongly,* and *mildly disagree* choices are more expected to be in the inferior outcome groupings, than those lacking. The significance level of the test for the support from *"significant others"* is p= .011, less than 0.05, indicating that each observed effect is not due to extraneous variables. Meanwhile, each of its coefficients is positive; therefore, as support in low or moderate categories increases, so does the possibility of being in one of the greater cumulative outcome categories of SELS beliefs.

"Worth of statistics" also contributes to the model in an expressive method. The respondents with a low positive attitude, are more possible to be in the higher conclusion types, compared to those wanting. The significance level of the test for "W*orth of statistics"* is p= .012, less than 0.05, revealing that its perceived influence is not due to an unforeseen event. Its constant estimate is negative; therefore, as "*worth of statistics"* rises, so the likelihood of being in a higher cumulative outcome category decreases, or as "*worth of statistics"* decreases, the prospect of being in higher collective result types improves.

Table 6.18: Parameter estimates

Item names	R. coeff.	P-value		Item names	R. coeff.	P-value
[SelfEffAbsMeanOrd = 2]	4.229	.013		Support- Sig. Others	1.312	.011
Experiences in RM	.128	.738		Family support	.690	.141
Experiences in Stats	-.416	.265		Friend support	-.644	.097
Test factor	-.366	.429		Postgraduate prog.	.685	.228
Interpretation factor	.652	.192		Marital status	2.173	.003
Ask for help factor	1.147	.010		[Age group=1]	.716	.558
Worth factor	-1.824	.012		[Age group=2]	.823	.404
Self-comput factor	.806	.189		[Age group=3]	.530	.534
Teacher factor	1.091	.023		gender	-.186	.726
Affect factor	1.155	.008		Ethnic group=0	1.831	.190
Cognitive compet.	-1.210	.010		Ethnic group=1	-.015	.993
Value factor	.401	.257		Ethnic group=2	7.653	.002
Difficulty factor	-.652	.057		Student status=0	-1.426	.189
Interest factor	.226	.495		Student status=1	-1.058	.257
Effort	.081	.817		Type of study	-2.386	.017

Link function: Cauchit

However, "*cognitive competence*" appears to be a significant predictor on the overall SELS beliefs. Students with low anxiety are more likely to be in the lower consequence classifications, than those deprived of. The significance of the test for "*cognitive competence*" in average category is p= .010, less than .05, revealing that its detected result is not owing to unintended. Its constant is negative; therefore, as "*cognitive competence*" increases, so the likelihood of scoring in higher category decreases, or as "*cognitive competence*" decreases, the probability of recording in one of the higher collective outcome classifications increases.

Regarding the covariates, *marital status* proves to be a significant predictor of the overall SELS beliefs. Students with s*ingle status* are more likely to be in the lower outcome groups than those lacking. The significance of the test for *marital* *status* in a single category is p= .003, less than 0.05, with a substantial coefficient estimate. The effect of the variation observed in the probability of the cumulative outcome category of the overall SELS beliefs is explained by *marital status*. A positive coefficient reveals that as *marital status* increases, so does the possibility of being in one of the higher cumulative outcome classes.

Similarly, *ethnic groups* displays an extensive contribution in the model. Students in the Indian/Asian group are more possible to be in the inferior outcome categories, compared to others. The significance of the test for Indian/Asian group is p= .002, with the highest positive coefficient estimate. Unfortunately, the type of study negatively associated with the overall SELS beliefs. Full time students are more likely to score in the higher product categories, compared to part time students. The significance of the test for full time students is p= .017, less than 0.05, with a considerable coefficient estimate. However, the type of study is one of the reasons for the change observed in the probability of the higher growing result classes. The sign of the coefficient estimate is negative, showing that as type of study intensifies, so the possibility of being in upper aggregate outcome category decreases, or as type of study decreases, the probability of recording in one of the upper aggregate outcome categories increases.

By contrast, *gender*, *"experience in research methodology"*, *age groups*, *"interest" factor* and "*test and class anxiety" factor* add very little to the model, while there is no particular category of *support from "family members"*, *support from "friends"*, "*difficulty"*, "*interpretation"*, "*experiences in statistics"*, *postgraduate programmes* and *ethnic groups* that is significant on its own. Specifically, "*interpretation"*, *'self-computational"*, *support from "family members"*, *student status*, *support from "friends"*, and "*difficulty"* are slightly meaningful. Typically, keeping such a factor in the model with the small effect of each category combined produces useful evidence to the model. Fascinatingly, while students with moderate positive attitudes in difficulty are more probably to be in the higher outcome categories, than those with low positive attitude, those with neutral attitudes in *support from "significant others"* are less expected to be in the lower effect types, compared to those who achieved agree in *support from* "*significant others*" outcomes.

6.2.4.6. Principle of parsimony

The standard of meanness was appropriate to the building of the "ordinal regression" model. The argument is that if the complete models, comprising all explanatory variables are too multifaceted, it could end in imprecise assessment of the factors and unpredictability of the model structure (Elamir & Sadeq, 2010). If the occurrence dispersal of the ordered categorical results revealed that the data points were consistently distributed in many classes, then the Logit link function might be appropriate. In fact, there was no clear-cut choice of link functions. If one link function did not afford a good fit to the data, then the other link function might be a practical substitute (Elamir & Sadeq, 2010). Founded on the overhead demonstrating strategy, the model with the Logit link was built to comprise 24 explanatory variables.

6.2.4.7. Predictive value of the model with Logit link

The reduced model analysed 151 of the 156 cases, and excluded five (5) questionnaires from the study, because of having at least one item with missing records or a *not appropriate* score. The result of the "Pearson's chi-square" test ($\chi 2$ = 59.416 with d.f. of 37 and p = .011) indicated that the model with the Logit link fitted the information.

Table 6.19: Model-fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	298.267			
Final	238.851	59.416	37	.011

Link function: Logit

6.2.4.8. Test of parallel lines

In this test, the statement that the restrictions were the same for all response categories is investigated. According to Table 6.20, the significance of the test for Pearson's Chi-square indicated a large value (p= .625). There was no adequate indication to reject the parallelism assumption. This confirms that the selected organization of the classes of the dependent variable was consistent. An ordering that places *little confidence* as a greater value may have a better fit. The model assumption of parallel lines in the model with the Logit link was (e.g., $\chi^2 = 33.69$ with d.f. of 37 and p = .625). The results of the model in the logit link did not violate the model assumption of parallel lines, and convergence is attained.

Table 6.20: Test of parallel lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	238.851			
General	205.161[b]	33.690[c]	37	.625

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

6.2.4.9. Pseudo R-squared measures

Three pseudo R-squared measures, described in Table 6.21, confirm that the model with Logit link fits the outcome data. However, the highest pseudo R-squared measure represents the best model to guess the effect. Therefore, Nagelkerke/Cragg & Uhler's measure indicated the best (38%), followed by Cox & Snell's (33%) and McFadden's (20%), which was the smallest. The standard indicates that Cox & Snell's pseudo R-squared has a extreme value that is less than one. If the full model perfectly envisages the outcome and has a possibility of 1, Nagelkerke/Cragg & Uhler's R-squared measure = 1.

Therefore, the model in Logit link was a worthy model. The three pseudo R squared measures – McFadden's (20%), Cox and Snell's (33%), and

Nagelkerke/Cragg & Uhler's (38%) – were higher for the model in Logit link, compared to the model with Cauchit link.

Table 6.21: Pseudo R-squared measures

Cox & Snell	.325
Nagelkerke/Cragg & Uhler	.378
McFadden	.199

Link function: Logit.

6.2.4.10. Interpreting the model

Using the complete model with the Logit link, one threshold of the model equation was meaningfully dissimilar from zero, and yield substantially to the values of the response possibility in the diverse classes of the three explanatory variables, namely, "*experiences in statistics*", *ethnic groups* and *postgraduate programmes*, as illustrated in Table 6.22. In addition, the SELS beliefs was expressively connected with the three explanatory variables. Two of the three significant explanatory variables (*ethnic groups* and *postgraduate programmes*) showed positive regression coefficients, signifying that the students, who scored greater in these independent variables were expected to score upper in the SELS beliefs.

The variable, *ethnic group*, performed very well in this model. The significance of the test for this covariate was p= .017, revealing that the variation observed in the dependent variable was expected. The coefficient was positive; therefore, as the variable of *ethnic group* intensifies, so does the possibility of being in one of the higher classes of SELS beliefs. Similarly, the variable, *postgraduate programmes*, was found to be significantly associated with the overall SELS beliefs. The significance of the test for this factor was p= .042, revealing that the dependent and the explanatory variable moved in the same direction; therefore, as the variable, *postgraduate programmes*, decreases, so does the likelihood of existing in one of the smaller classes of the dependent variable, and vice-versa.

Table 6.22: Parameter estimates

Item names	R. coeff.	P-value		Item names	R. coeff.	P-value
[SelfEffAbsMeanOrd = 2]	4.589	.032		[Agegp=1]	.572	.588
Experiences in RM	.203	.502		[Agegp=2]	.455	.597
Experiences in Stats	-.615	.033		[Agegp=3]	.134	.856
Test factor	.025	.944		gender	-.109	.797
Interpretation factor	-.229	.554		Ethnic group=0	1.740	.113
Ask for help factor	.530	.099		Ethnic group=1	1.082	.364
Worth factor	-.761	.149		Ethnic group=2	3.529	.017
Self-computational	.386	.405		Student status=0	-1.077	.221
Teacher factor	.519	.160		Student status=1	-.837	.267
Affect factor	.009	.978		Type of study	-1.216	.165
Cognitive competence	-.493	.149		Department=1	.022	.992
Value factor	.342	.251		Department=3	-19.835	.997
Difficulty factor	-.170	.491		Department=5	1.681	.320
Interest factor	.111	.681		Department=7	1.713	.274
Effort factor	-.157	.598		Department=8	1.417	.358
Support- Others	.272	.431		Department=9	.549	.720
Family support	.670	.053		Department=10	1.389	.312
Friend support	-.451	.153		Marital status	.808	.128
Postgraduate prog.	.997	.042				

Link function: Logit

Additionally, experiences in statistics was significantly associated with the overall self-efficacy to learn statistics (p= .033), with a negative regression coefficient (-.615). Therefore, as *experiences in statistics* increases, the probability of being in one of the smaller categories of self-efficacy to learn statistics decreases, or vice-versa. *Gender, "affect" factor, age groups, "interest" factor, "effort" factor, department* and "*test and class anxiety" factor*, added insignificantly to the model. However, "*worth of statistics" factor, "ask for help", "fear of statistics teacher", "cognitive competence", "value" factor*, support from *"family members", type of study, marital status, "experiences in research methodology", "interpretation of statistics" factor, "computational self-concept", "difficulty" factor,* support from *"significant others"* and *student status* were slightly important. Frequently, it is important to keep such a factor in the model, since the small possessions of each group accrue and afford valuable material to the model.

6.2.4.11. Evaluation of the accuracy of the classification response categories

The exactness of the organisation outcomes for the approval response classes are illustrated in Table 6.23. The complete model, with the Logit link, arranged the classes of *little confidence* (76.3%), *a fair amount of confidence* (57.4%), and *much confidence* (23.8%). The model established a fairly great expectation exactness (62.25%) for all three classes joint.

Table 6.23: Cross-tabulation

Current response Categories		Predicted Response Categories			Total
		A little confidence	A fair amount of confidence	Much confidence	
A little confidence	n	58	17	1	76
	% within Current Response Category	76.3%	22.4%	1.3%	100.0%
A fair amount of confidence	n	20	31	3	54
	% within Current Response Category	37.0%	57.4%	5.6%	100.0%
Much confidence	n	4	12	5	21
	% within Current Response Category	19.0%	57.1%	23.8%	100.0%
Total	n	82	60	9	151
	% within Current Response Category	54.3%	39.7%	6.0%	100.0%

If the standard of meanness was measured to be the most significant modeling approach, then the complete model, with the Cauchit link, might have been a better model, when matched to the whole model, with the Logit link. The complete model, with the Cauchit link, seemed to be the best model in this study, based on the model fitting statistics, the correctness of arrangement results, with the great expectation accuracy (75.49%) for all three classes joint.

6.2.4.12: *Correlation estimated classification probability between predicted and actual category*

The relationship between estimated classification probability for predicted and actual category was examined using Spearman's rho correlation coefficient. Table 6.24 indicates that there was a strong relationship found between the predictable arrangement likelihood for predicted, and estimated classification probability for real category. The findings indicated rho =.680, n =151, p < .000. A positive correlation coefficient implies that a lesser increase in the estimated classification probability for predicted category is associated with a lesser increase in the estimated classification probability for actual category; or a lesser decrease registered in the estimated classification probability for predicted category, is connected with a lesser reduction in the estimated classification possibility for actual category. The strength of the correlation is 46.24%, which is impressive.

Table 6.24: Correlation between predicted and actual category

			Estimated Classification Probability for the Predicted Category - UWC Cauchit	Estimated Classification Probability for the Actual Category - UWC Cauchit
Spearman's rho	Estimated Classification Probability for the Predicted Category - UWC Cauchit	Correlation Coefficient	1.000	.680**
		Sig. (2-tailed)		.000
	Estimated Classification Probability for the Actual Category - UWC Cauchit	Correlation Coefficient	.680**	1.000
		Sig. (2-tailed)	.000	

**. Correlation is significant at the 0.01 level (2-tailed)
b. Listwise N = 151

6.3. Qualitative findings

In this section, the researcher presents the results of the study, starting with a description of the participants. The qualitative data are transcribed and reported accordingly, while the results are discussed in Chapter 8 of the thesis.

6.3.1. Description of the Study Participants

Initially, the sample of participants was seven; however, two participants (Black African male and female) withdrew during the interview session. Therefore, five participants were interviewed, comprising two females and three males, mostly aged older than 35 years old. Their racial and academic statuses were four coloured and one white, one master's student and four PhD students. Interestingly, they were also staff members, who described themselves as such, teaching statistics at undergraduate level at UWC.

6.3.2. Participants' Responses

All the responses from five participants (Resp.1-5) are presented below, extracted from the semi-structured interview data gathered:

How did you decide to choose the test? Or on what basis did you choose the test that you had chosen?

Resp. 1: *"I was looking at the outcome that was needed humm, so depending on what will be testing so what outcomes were desired, I have been choose the test based on that."*

Resp. 2: *"Eheee, first at all, I tried to remember what I have learnt in statistics and then I looked for keywords that I will identify certain properties or characteristics of certain tests, then I looked at the data that was given, see as the size of the samples something like that, a process of thinking so going back to my undergraduate courses what I have learnt looking at the sample sizes the data that was given and then trying to make a decision based on that".*

"Ok, for certain things there wasn't options, certain things it was that test and only that test could be used but the other thing that I was confused it was you have to look at for sample is model one sample, if it is only for example one sample if it is dependent or not independent, thing like that so those are the type

of things you do have to look for instead of see how the data is displayed in the table that it gives you some directions in which to go. And then you have to make a selection. Eheee especially with the correlation, there are different types of correlation you can do so you have to see based on actual information that's given to you, number of samples, is it repeated, thing like that totally give you better understanding of what test to select."

Resp. 3: **"***I read what information they give me right, and then, what I do I look at the test they gave me right. Now, there are certain information in the problem that they give me, like I would look at like say even they have given like a correlation and I will look at those tests where I know they make use of correlation Ok; and then, there were tests where the question wasn't clear I mean the problem phrase wasn't so clear and then I would look at what type of analysis would I use humm especially with the factor analysis, discriminant analysis then I would look at that type of analysis I will implement."*

Resp. 4: "*Ok, on the high level for me when doing any research and relating to your research questions what is your objective is looking at the data, the high level question you have to ask yourself is what are the type of data I'm working on? Ok, at also choosing a statistics test really also humm goes handling with looking at the type of research done that similar to the research you have done and the type of test that was performed for that research it is not necessary one test that could work for the same research there is multiple tests and if there isn't a type of test that would rather serve to your objective you could consult you know with more senior statisticians to come up with a test which could satisfy your conditions."*

Resp. 5: *"I need to look to data or at least the questions, I could have feeling for what look familiar about it some have very familiar looking something could be a t-test or basic science test, that could be my major decision and then as I went too long, I would realize my power might be very low of my test, so if I had other option, I would consider that test but then I consider alternative test for high power you know to reject the null hypothesis."*

"I suppose to the similar previous answer I think my decision was based on I will give maybe three reasons naturally just considering a type of question so giving

or making assumption about the distribution taking a looking at any kind of possible weaknesses in the model or non-normality or the skewness of the distribution could be a possibility then I considered power in terms of rejecting for promises".

Which information in the item alerted you to that choice? What will the test tell you?

Resp. 1: *"It was the combination of two things, the combination of the data itself; so I was looked at what data was available but and again using the outcomes and match the outcome to the type of the data that was available and I use those two criteria to evaluate."*

Resp. 2: *"Ok, as I said that again, you have to read everything and see what information is given to you, how the table is formulated or displayed how the information is displayed to you and then looking for words specific are like prediction, I saw a few times relationship between things, association, those type of words highlight to you, certain tests need to be performed; you have to look for those type of words and what information is given to you and then decide how to use it and what test will give you the right information."*

Resp. 3: *"First, I will look at those tests which I know right and I will look at the problem the item if the item has information which fits the test then I will link it if there is no link then I will need to look at the different test."*

Resp. 4: *"Looking at the type of variables, looking at the data, the difficult think for me with this questionnaire for me I can ask questions ehee because some of the information yesterday but for me I would want to know more, so I found a little bit difficult actually answer these questions the way I could because I'm the type of person that who want do something tiredly that would also took so long I don't like just quick, quick you know eheeeyah."*

"It depends on the objective again, so because handling hand with lot of objectives, depend on what you want to answer."

Resp. 5: *"Sometimes the question would be rather leading, humm, that was generally I could on the occasion there be particular the same information I can missing data, items, there was a situation where, there was I can't remember* *entirely but I think there was the bit of the good feeling the data might be a quite skewed and that could give me a more non-parametric approach opposed to parametric approach."*

"Generally I think there was hypothesis there was requiring and hopefully that would be able to give me confirmation of my feeling about the particular restriction of cause or rejecting of that hypothesis."

Was it difficult to decide?

Resp. 1: *"Yes, most of the tests that were available are not my specialty; they are not tests that I usually used so yes it was little bit difficult to decide."*

Resp. 2: *"Sometimes it was, sometimes I couldn't make the decision because I really didn't know and if it is a real life situation, then you have to do some research. Humm, that is all what we all have to do research to find out you know what is the best test or contact some of your colleagues if you don't know and discuss certain things like that because sometimes somebody else has better information and you have so. Sometimes I didn't know honestly, I didn't know what to do, so I just left that, I didn't know what to choose."*

Resp. 3: *"Yes, there were some tests which is difficult to decide …humm because it's not a lot of information is given but a very last one where they give the observed, I wanted to apply a chi-square test but because the keyword in this correlation, you can't apply the chi-square to really a correlation, so I look at the other possibility of the correlation test and since, there I'm using the scenario that I'm not familiar with so that one was difficult."*

Resp. 4: *"Look at it, is difficult in the sense especially you don't work with certain scenarios on the daily basis or it is not your area of expertise within the statistical field that's make it very very difficult because you know there is so many conflicting concepts in statistics you know certain statisticians believe, some people believe qualitative data can actually be quantitative because you should code, there is lot of debates around certain key concepts in statistics so it could be very confusing especially if it is not something you do daily; that's so I found because I'm newly back into this field again."*

Resp. 5: "*Yeah, ahahahaha, often, not always, often."*

Which information in the item made it difficult?

Resp. 1: "*The outcomes again the outcomes.*"

"Depending of the outcomes that are needed I guess, the scenarios and the data also available."

Resp. 2: *"Humm, maybe that it wasn't difficult to choose, just say maybe I didn't know all of the statistical tests are there; I wasn't familiar with all of the tests so I couldn't decide what to use maybe to just little information to me to make a decision."*

Resp. 3: *"Specifically those items where the information given is not very clear; you know, not a lot of information given to be able to fit a specific test to that item."*

Resp. 4: *"Look if your scenario has a certain nature where, if multiple variables and there is especially when you can identify multiple tests that could be used for the same scenario that for me I could you know difficult to decide, for me then I would rather do let's strobe wait and see and then logically loud it out."*

Resp. 5: *"I think just the lack of exposure to certain kind of techniques, I think I haven't for a long time use some techniques, some I have never been exposed to certain book of reading, and then also … in fact the information was not completed in terms you didn't see the data if you could plug it you could make it feel a little bit more comfortable or you could run a little bit of pre-test on it you feel little bit more comfortable."*

Did alternative possibilities come to mind?

Resp. 1: *"No, because unfortunately I haven't test any of these tests and it wasn't in my area. Unfortunately, no I only use what was given to me to analyse which test to use."*

Resp. 2: *"Humm, especially for the correlation questions, association, relationship between things, they have different options of pursue then you have to read further and look at how the information is given to you to decide which type of correlation you have to choose; so there are always it's might be options and decide to go further little bit then see what is given to you it's one sample, is* *it two samples, is it independent, not independent thing like that and then you can see which one to select basically."*

Resp. 3: *"Yes, it was quite a few but because of lack of information in the scenario, you can't really now say easy that one you know in real life you just apply the different alternative; but in this case, there wasn't a plan where you can ask for extra information."*

Resp. 4: *"Yeahh, of course."*

Resp. 5: *"Absolutely."*

Why were some tests rejected? / Did you think about some assumptions that you suppose to apply?

Resp. 1: *"I taught it didn't apply to the data that was available. If I didn't think that the test could be use according to the data available, I didn't choose that test."*

Resp. 2: *"Weeeehe, well if you don't humm add here some of the rules of the specific tests so humm, it will give you the type of information as given to you will direct you in a certain way."*

Resp. 3: *"Yes, they suppose like eehe none of the problem that I see where they will ask you the data is normal? There was one way they say invented data, now what does invented data means? Usually in this area invented data will be simulated data, you understand and you usually use simulated data to get estimates."*

Resp. 4: *"If it doesn't satisfy the criteria for the test, you know. You can do a t-test if there is no…whatever…"*

Resp. 5: *"I choose particular ones initially because of easy views and then I would often reject because I sound realise certain assumptions do not permit or allow and then there was not enough power."*

How confident are you about the decision you made?

Resp. 1: *"Hauf, I feel very confident. This, I am core confident."*

Resp. 2: *"The one that I have answered I'm confident, some of them I wasn't very sure but I didn't know which other option to select. So some of them I took a guess especially with the comparing of the mean questions I took a guess there; humm yah I wasn't exactly sure about that one."*

Resp. 3: *"The easy ones, I'm very confident; …humm the ending are the difficult ones because there were possible choices. Ok, I don't use the parametric tests a lot which is applicable to normal test also, so I rather went for the easier test which is a normal assumptions and I stay away from the non-parametric test."*

Resp. 4: *"Look, I didn't spend too much time and I couldn't ask a lot of questions on the scenarios and I'm feeling confident I think, really."*

Resp. 5: *"I considered very confident."*

Please mention any items that you are not familiar with. / May you mention some names?

Resp. 1: *"In terms of the tests? Post-hoc test for comparison of means, Factor analysis, Discriminant analysis, Semi-partial correlation, Kruskal and Wallis for One-way ANOVA for ranked data, Friedmann Two-way ANOVA for ranked data, Path analysis and Sandler's A statistics."*

Resp. 2: *"Ok, I will start at the bottom, the number 34 a Sandler's A test; Path analysis; the Fischer exact probability test; Discriminant analysis, the Sign test, I'm not familiar with. Fisher z transformation, Factorial ANOVA, I'm not familiar with the Post-hoc test comparison of means that's number 12 but I guess that one because just because of the words …humm, what else's. The Partial and Semi-partial correlation I'm not familiar with together that's all it."*

Resp. 3: *"Humm, the very last one Sandler's A statistics, I have no idea what it is; …humm, the Semi-partial correlation I haven't heard about, …humm, Partial correlation …humm, the Fischer Z transformation I won't say I'm not familiar with it but usually you do that for when you sit with the problem in your cells have small but I'm familiar with I want to know about but it is the way they say transformation usually you say Fischer exact test which is later on Fischer Z probability test; so… yah. Fischer exact Z transformation doesn't make sense to me but, effect size, usually you say sample size so effect size right there usually* *you look like at in the inter axes but effect size I look at the problem then I couldn't see effect size what was the effect size I wasn't sure what the meaning of effect size; humm… Z statistics … Yahh, I won't say I'm not familiar but in other item that I look for I did choose one and use it but rather it should have been Z score than Z statistics or Z-test; it would be better than Z statistics let's put like confusing.'*

Resp. 4: *"Look there is lot of items I haven't come across like Path analysis or Sandler's A statistics, some of the tests are very widely used and common some tests are very specific for certain type of faculties or disciplines in the sense if you know what I mean, so I wouldn't necessarily come across these are even few that I haven't even seen before and even calculate before."*

"Yeah, Path analysis, Friedman, Two way, Sandler's A statistics, Discriminant analysis."

Resp. 5: *"I did myself unfair but I did study over items before I did the test. I went over all of them on the computer because I doubt the most of them I gonna pass. I would mention a few, number 9 the effect size I just want to know that refers to, I had really be exposed to all of those on the first page except the effect size, I little be confuse in, between 28 and 20 (Partial correlation and semi-partial correlation), I have been exposed to it but I don't remember the difference, I read that but I haven't convince of my understanding. Sandler's A statistics, I haven't seen it in my life the rest I'm familiar with it but I wasn't able to use them in my answers, I wasn't confident enough."*

What are your feelings towards a choice of statistical test?

Resp. 4: *"For some scenarios it's easy you can be confident because it's straight forward but the more complex objectives, the more conflicting your choices would be in terms of your decision; that's why I would say then, look at what has done try multiple different tests that could at least the test must satisfy the criteria to do the test you must make sure that you satisfy those criteria people you use it because otherwise you gonna come up with non-sense statistics."*

What factors hinder recovering the choice of statistical test?

Resp. 5: *"Hoooo, I suppose it could be lack of confidence, in my understanding of a, the data and b, the test itself I think with common test the normal test with the data is it normal can I make the assumptions, with the less common test I would be better talking about assumptions that would making humm without understood the test completely correct."*

Constructivists view students as transporting their own concepts, understandings, and principles to their academic work, which, in turn, affect how they appreciate and absorb new material. Rather than *receiving* material in class as it is *delivered*, students reorganise the new information to fit into their own reasoning backgrounds. In this manner, they actively and individually build their own knowledge, rather than replicate knowledge *transmitted* or *conveyed* to them. Therefore, various themes and sub-themes arose from the comments of the participants, which were grouped into three main themes, namely, *the ability to choose a statistical test*, *perceived failures to choose the right test* and *non-familiar items.*

The main theme, *ability to choose a statistical test,* produced three sub-themes, namely, *major concerns about a choice of a correct statistical test*, *practical knowledge to choose a statistical test* and *confidence about the decision made*. Similarly, the main theme, *perceived failures to choose the right test,* produced two sub-themes, namely, *causes of difficulty to select a statistical test* and *reasons of rejection of some tests*. Regarding the main theme, *non-familiar items,* produced how the background of the respondents, the performance, the level of motivation, level of knowledge, exposure to the statistics programmes were contributing factors to the degree of familiarity of students with various items. A detailed analysis of findings is presented in Chapter 8.

6.4. Synthesis and partial conclusion

In this chapter, the researcher presented the results of the analyses of UWC data. The analyses include quantitative and qualitative findings. The quantitative analyses were based on three main stages, *the univariate analysis of variables* obtained from the questionnaire, *the bivariate analysis* and *multivariate analysis* with "ordinal regression" models, using Cauchit and Logit link functions. All these stages were completed for the UWC data.

The descriptive analysis reported summary frequencies, percentages, means, standards and graphs. The bivariate analysis concentrated on the impact of the independent variables on the SELS beliefs. The results of the bivariate analysis highlighted the postgraduate programmes, marital status, gender, SITSTATS, STASTATS, STARS, and experiences in research methodology were statistically, significantly different in the means scores of SELS beliefs for groups. Regarding the multivariate analysis, its results were statistically strong due to the consideration of control in the model. The ordinal regression assumed that the independent variables predicted the level of SELS beliefs, significantly. The results of the ordinal regression, using Cauchit link function, was suggested as the best model that the "*ask for help", "worth of statistics", "fear of statistics"* monitors, *"affect" factor, "cognitive competence", ethnic groups, marital status, type of study* and support from *"significant others"* were the significant predictors of SELS beliefs. The participants' characteristics were presented in the first section of the qualitative analysis, while the transcribed records, as well as the reported results, grouped into themes and sub-themes, were addressed in the second section.

CHAPTER SEVEN

COMPARATIVE QUANTITATIVE RESULTS OF BOTH UNIVERSITIES

7.1. Introduction

In this chapter, the researcher only focuses on quantitative results, based on the quantitative data gathered from UCT and UWC. For the qualitative analysis, to avoid repetition, the findings presented in Chapters 5 and 6, are discussed in Chapter 8. Therefore, in this chapter, firstly, the description of the variables is addressed for the combined data. Subsequently, the comparison of factors are presented, across universities, to reveal that *gender, age groups, ethnic groups, "effort", social support* and *STARS* components are significantly associated to the academic institution. In addition, these comparisons will reveal that *postgraduate programmes*, "*experiences in research methodology", STARS* and *social support* components are significantly different in means scores of SELS beliefs, across universities. Ultimately, it will confirm that an ordinal regression model, using a complementary log-log link function was the best model for this current study, showing high prediction accuracy of 60% for all three categories combined. This current study will not only provide a general idea of the student's level of learning statistics, but also the degree of contribution to sustainable development of learning statistics, at the Western Cape universities.

7.2. Descriptive analysis

In this section, the researcher describes the students' characteristics, using individual information obtained from the questionnaire. All variables involved in the study are concise in the tables and figures. The information includes frequencies, percentages, mean scores and standard deviation. These variables were *background information, experiences, STARS, SATS, social support* and *SELS beliefs.*

7.2.1. Background Information

The results, illustrated in Table 7.1, described that 307 enrolled students in postgraduate programmes completed the quantitative questionnaire at both universities (UCT and UWC). The amount of male students dominated the quantity of female students, with 196 (63.8%) males, compared to 111 females (36.2%). Black African students were the dominant ethnic group, with 184 (59.9%), followed by White students, 55 (17.9%). The

Indian students represented the smallest ethnic group, with 19 (6.2%). The majority of the students were aged between 26 and 30 years, with 129 (42%), while the youngest group was represented by 52 (16.9%), and the oldest age group, by less than 10.1% (31). In addition, regarding the students' marital status, 82 (26.9%) were married, while 203 (66.6%) were single. The full-time students comprised 284 (92.8%). Regarding their nationality, 151 (49.5%) were South African, with only 30 (9.8%) being non-African. Of the participants, 187 (61.5%) were enrolled in master's programmes, 105 (34.5%) in PhD studies, while 3.9% were post doctorate students. Regrettably, three postgraduate students did not indicate in which programmes they were enrolled.

Table 7.1: Description and Chi-square individual characteristics for both universities

Characteristics	UCT		UWC		Total		X^2	P-value
	N	%	N	%	N	%		
Gender							20.588	.000
Male	116	76.8	80	51.3	196	63.8		
Female	35	23.2	76	48.7	111	36.2		
Age groups							11.22	.011
20-25	33	21.9	19	12.2	52	16.9		
26-30	65	43	64	41	129	42		
31-40	45	29.8	50	32.1	95	30.9		
41 and +	8	5.3	23	14.7	31	10.1		
Ethnic groups							53.858	.000
African	74	49	110	70.5	184	59.9		
Coloured	14	9.3	35	22.4	49	16		
Indian	14	9.3	5	3.2	19	6.2		
White	49	32.5	6	3.8	55	17.9		
Total	**151**	**100**	**156**	**100**	**307**	**100**		
Type of study							.624	.430
Full time	141	94	143	91.7	284	92.8		
Part time	9	6	13	8.3	22	7.2		
Total	**150**	**100**	**156**	**100**	**306**	**100**		
Marital status							6.112	.191
Single	105	70	98	63.2	203	66.6		
Married	32	21.3	50	32.3	82	26.9		
Divorced	2	1.3	1	0.6	3	1		
Widow	1	0.7	1	0.6	2	0.7		
Cohabiting	10	6.7	5	1.6	15	4.9		
Total	**150**	**100**	**155**	**100**	**305**	**100**		
Student status							.267	.875
South African	73	49	78	50	151	49.5		
African	60	40.3	64	41	124	40.7		
Non-African	16	10.7	14	9	30	9.8		
Total	**149**	**100**	**156**	**100**	**305**	**100**		
Postgrad.							.9	.638
Master	93	62.8	94	60.3	187	61.5		
PhD	48	32.4	57	36.5	105	34.5		
Post-Doc	7	4.7	5	3.2	12	3.9		
Total	**148**	**100**	**156**	**100**	**304**	**100**		

7.2.2. Experience components, mean scores and standard deviation

Various studies have highlighted the challenge of learning statistics at school, undergraduate and postgraduate level, as well as its impact at university (Garfield, Hogg, Schau & Whittinghill, 2002; Makapela, 2009). In this section, the researcher explores the background of *experiences*, prior to the current programme of graduate students, comprising their performance in postgraduate studies, given that they had taken statistics courses during their undergraduate studies, or at school. The findings of experiences are illustrated in Table 7.2. The "*experience in research methodology"* component scored in the *good* category, which was the highest, with 182 (59.3%), followed by the *average* category, with 85 (27.7%). The *experience gained in statistics* component, scored less than 0% in the *very bad* category, while 127 (41.4%) was achieved in the *good* category. The same trend was observed for the *overall* experience component. The means score achieved in *experience gained in statistics* component was lower (3.4), compared to those attained in both "*experience in research methodology"* and the *overall* experience (3.7) components. Therefore, the postgraduate students were more reliable in the "*experience in research methodology"* component, than in the "*experience in statistics"* component.

Table 7.2: Experience components

Component	Very bad n (%)	Bad n (%)	Average n (%)	Good n (%)	Excellent n (%)	Total	Means	SD
Exp. RM	0	11(3.6)	85(27.7)	182(59.3)	29(9.4)	307	3.7	0.7
Exp Stats	6(2)	26(8.5)	125(40.7)	127(41.4)	23(7.5)	307	3.4	0.8
Experiences	1(.3)	8(2.6)	103(33.6)	170(55.4)	25(8.1)	307	3.7	0.7

Source: Own computation using compile data set universities

7.2.3. STARS Components, Mean Scores and Standard Deviation

Regarding the STARS components in Table 7.3, the "*computational self-concept"* component reached its highest score in the category of *no anxiety*, at 130 (42.3%), followed by low anxiety 109(35.5%). In addition, the rest of the STARS components reached their highest scores in category of *low anxiety*, while the category of *very high anxiety* recorded the lowest scores in all the components. The *test and class* component presented a mean score of 2.63 (rounded off to 3), indicating the third category, *moderate anxiety*, while the other components indicated the second category of *low anxiety* for their mean scores (being > 1.5 but < 2.5; therefore, rounded off to 2).

Table 7.3: STARS components

Components	No anx.	Low anx.	Mod. Anx	High anx.	Very high	Total	Means	SD
Test and class	35(11.4)	109(35.5)	109(35.5)	44(14.3)	10(3.3)	307	2.63	.973
Interpretation	56(18.2)	126(41)	102(33.2)	19(6.2)	4(1.3)	307	2.31	.886
Ask for help	78(25.4)	108(35.2)	89(29)	28(9.1)	4(1.3)	307	2.26	.981
Worth of stats	92(30)	145(47.2)	52(16.9)	15(4.9)	3(1)	307	2.00	.869
Fear of stats monitor	105(34.2)	130(42.3)	56(18.2)	15(4.9)	1(.3)	307	1.95	.865
Comput. Self-concept	130(42.3)	109(35.5)	53(17.3)	11(3.6)	4(1.3)	307	1.86	.916
STARS	52(16.9)	175(57)	70(22.8)	9(2.9)	1(.3)	307	2.13	.728

Source: Own computation using compile data set universities

7.2.4. SATS Components, Mean Scores and Standard Deviation

The SATS components, namely, "*affect*", "*cognitive competence*", and "*value*" recorded 3 (1%), 2 (0.7%), and 3 (1%), respectively, in the *lowest positive attitude* category. In addition, these components registered 3 (1%), 4 (1.3%), and 3 (1%), respectively, in the *highest positive attitude* category, while in the *low positive attitude* category, they registered their highest scores of 117 (38.1%) for "*affect*", 125 (40.7%) for "*cognitive competence*" and 159 (51.8%) for "*value*". The components, "*difficulty*", "*interest*" and "*effort*" presented a different structure by registering their highest scores in the *moderate positive attitude* category for "*difficulty*", at 142 (46.3%), the *high positive attitude* category for "*interest*", at 105 (34.2%), and in the *higher positive attitude* category for "*effort*", at 82 (26.7%). Additionally, the lowest scores were reached in the *lowest positive attitude* category for two components ("*Cognitive competence*" and "*Difficulty*") with 2 (0.7%), respectively, and the highest score was for *overall SATS* with 183 (59.6%) in the *moderate positive attitude* category (see Table 7.4 below).

Regarding the mean scores, the "*value*" component's mean score was 3.4 (rounded off to 3, being < 3.5), indicating the third category, *low positive attitude*. The "*affect*", "*cognitive competence*", "*difficulty*" and *overall SATS* components' mean scores were rounded off to 4 (being > 3.5 and < 4.5), indicating the fourth category, *moderate* *positive attitude*, while the "*interest"* and "*effort"* components were rounded off to 5 (being < 5.5), indicating the fifth category of *high positive attitude*.

Table 7.4: SATS components

Components	Lowest n (%)	Lower n (%)	Low n (%)	Moderate n (%)	High n (%)	Higher n (%)	Highest n (%)	Total	Means	SD
Affect	3(1)	22(7.2)	117(38.1)	100(32.6)	47(15.3)	15(4.9)	3(1)	307	3.7	1.1
Cognitive	2(.7)	18(5.9)	125(40.7)	105(34.2)	44(14.3)	9(2.9)	4(1.3)	307	3.7	1.0
Value	3(1)	34(11.1)	159(51.8)	77(25.1)	24(7.8)	7(2.3)	3(1)	307	3.4	1.0
Difficulty	2(.7)	20(6.5)	47(15.3)	142(46.3)	77(25.1)	16(5.2)	3(1)	307	4.1	1.0
Interest	7(2.3)	8(2.6)	18(5.9)	44(14.3)	105(34.2)	78(25.4)	47(15.3)	307	5.1	1.4
Effort	11(3.6)	7(2.3)	24(7.8)	51(16.6)	75(24.4)	82(26.7)	57(18.6)	307	5.1	1.5
SATS	0	10(3.3)	39(12.7)	183(59.6)	67(21.8)	6(2)	2(.7)	307	4.1	0.8

Source: Own computation using compile data set universities

7.2.5. Social Support Components, Mean Scores and Standard Deviation

The social support components (see Table 7.5), support from "*significant others"* and the *overall* social support presented the same result of 4 (1.3%), as the lowest score in the category *strongly disagree,* while support from *"family members"* and support from *"friends"* revealed 5 (1.6%) as a lowest score, also in the category *strongly disagree*. Additionally, support from *"significant others"* indicated its highest score of 91 (29.6%) in the category *strongly agree*, while the *overall* social support achieved 102 (33.2%) as its highest score, also in the category *strongly agree*. The component, support from *"family members"* recorded 101 (32.9%) as its highest score in the category *very strongly agree,* while support from *"friends"* registered 85 (27.7%) as its highest score in the category *mildly agree*. Support from *"family members"* displayed a mean score of (5.6), which indicated *strongly agree,* while the rest of the social support components achieved a mean score of *mildly agree.*

Table 7.5: Social support

Component	VSD	SDe	MD	N	MA	SA	VSA	Total	Means	SD
Sig. Other	6(2)	4(1.3)	21(6.8)	52(16.9)	58(18.9)	91(29.6)	75(24.4)	307	5.4	1.4
Family	5(1.6)	5(1.6)	12(3.9)	48(15.6)	51(16.6)	85(27.7)	101(32.9)	307	5.6	1.4
Friends	7(2.3)	5(1.6)	13(4.2)	48(15.6)	85(27.7)	76(24.8)	73(23.8)	307	5.3	1.4
Social sup.	5(1.6)	4(1.3)	14(4.6)	40(13)	85(27.7)	102(33.2)	57(18.6)	307	5.4	1.3

Option	Very Strongly	Strongly	Mildly	Neutral	Mildly	Strongly	Very strongly

	Disagree	Disagree	Disagree		Agree	Agree	Agree
Abbreviation	VSD	SDe	MD	N	MA	SA	VSA

Source: Own computation using compile data set universities

7.2.6. Self-Efficacy to Learn

7.2.6.1. Current self-efficacy (to solve)

Regarding *self-efficacy (SELS) to solve in Table 7.6*, the lowest scores are observed in the category *no confidence at all* for all sub-components, followed by *complete confidence* for "*emotional arousal*" at 20 (6.5%), *low confidence* for "*vicarious experiences*" at 21 (6.8%), and "*verbal persuasions*" 28 (9.1%). The sub-component *overall SELS to solve* was 28 (9.1%) in the *complete confidence* category. In addition, the highest scores are observed in the *much confidence* category for "*vicarious experiences*", "*emotional arousal*" and the *overall* self-efficacy, while "*performance outcomes*" presented its highest score in *a fair confidence* category and "*verbal persuasions*" in the category *very much confidence*. With 307 respondents, the mean score of all the components indicated the category 4 (being > 3.5 but < 4.5; therefore rounded off to 4), representing *much confidence*.

Table 7.6: Self-efficacy to solve

Component	NCA	LC	FC	MC	VMC	CC	Total	Means	SD
Perform.	18(5.9)	44(14.3)	74(24.1)	73(23.8)	62(20.2)	36(11.,7)	307	3.73	1.396
Vicarious	15(4.9)	21(6.8)	52(16.9)	84(27.4)	81(26.4)	54(17.6)	307	4.16	1.353
Verbal p.	16(5.2)	28(9.1)	49(16)	74(24.1)	85(27.7)	55(17.9)	307	4.14	1.405
Emotional	15(4.9)	53(17.3)	68(22.1)	85(27.7)	66(21.5)	20(6.5)	307	3.63	1.303
SELF-L	11(3.6)	36(11.7)	66(21.5)	91(29.6)	75(24.4)	28(9.1)	307	3.87	1.266

Option	No confidence at all	a little confidence	A fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using compile data set universities

7.2.6.2. Self-efficacy to learn (expectation)

Referring to Table 7.7, all the *self-efficacy (SELS) to learn* components registered the lowest score in the category *no confidence at all*. Two groups were formed regarding the highest scores observed. In the first group, "*performance outcomes*" registered 100 (32.6%), "*emotional arousal*", 92 (30%), and the *overall SELS to learn*, 93 (30.3%) in the category *very much confidence*. In the second group, "*vicarious experiences*" registered 95 (30.9%), and "*verbal arousal*", 101 (32.9%) in the *complete confidence* category. All the components' mean scores were rounded off to 5 (being >4.5 and < 5.5), indicating the fifth category of *very much confidence*, except for "*emotional arousal*" component that was rounded off to 4 (being <4.5), indicating *much confidence*.

Table 7.7: Expected self-efficacy (to learn)

Component	NCA	LC	FC	MC	VMC	CC	Total	Means	SD
Perform.	9(2.9)	20(6.5)	32(10.4)	57(18.6)	100(32.6)	89(29)	307	4.58	1.334
Vicarious	9(2.9)	9(2.9)	41(12.4)	67(21.8)	86(28)	95(30.9)	307	4.62	1.286
Verbal p.	8(2.6)	15(4.9)	33(10.7)	57(18.6)	93(30.3)	101(32.9)	307	4.68	1.305
Emotional	9(2.9)	21(6.8)	46(15)	64(20.8)	92(30)	75(24.4)	307	4.41	1.341
SELF-L	6(2)	18(5.9)	43(14)	66(21.5)	93(30.3)	81(26.4)	307	4.51	1.284

Option	No confidence at all	a little confidence	A fair confidence	Much confidence	Very much confidence	Complete confidence
Abbreviation	NCA	LC	FC	MC	VMC	CC

Source: Own computation using compile data set universities

7.2.6.3. Dependent variable: SELS beliefs

In Table 7.8, information from the 307 respondents is illustrated, ranging in SELS beliefs from 0.00 to 4.17, with a mean of .928, and standard deviation of .821. Regarding the equilibrium of the dispersal, positive skewness values (1.320) designate a clustering of ratings to the left, at the low values. In addition, positive kurtosis values show that the dispersal is rather peaked in the centre, with long thin tails. With a practically big sample (n = 307), skewness will not generate a substantive difference in the analysis (Tabachnick & Fidell, 2007). Kurtosis may produce in an undervalue of the variance, but the risk is also minimised with a large sample (150+ cases: Tabachnick & Fidell 2007). The mean score of the respondents could not inform the reader properly; therefore, it emerges from the difference between the *SELS to learn* and SELS *to solve*. However, the difference was modest in promoting the respondents' knowledge in real world problems, *conceptual, procedural understanding of statistical tests* and *unwillingness to draw attention student achievements*.

Table 7.8: Distribution current response category SELS

N	Valid	307
	Missing	0
Mean		.9284
Std. Deviation		.82064
Skewness		1.320
Std. Error of Skewness		.139
Kurtosis		1.961
Std. Error of Kurtosis		.277
Minimum		0.00
Maximum		4.17

7.3. Reliability of the scales for both universities

Reliability assesses whether the scales are sufficiently consistent (Krippendorff, 1980; Lachin, 2004). Internal consistency reliability was reported as a value of Cronbach's Alpha. Guiding the consistency tests established that the improved scales for the five factors, namely, *SELS, experiences, STARS, SATS* and *social support*, were relatively reliable (see Table 7.9). Regarding the *self-efficacy* factor, the validity evidence of current SELS was tested at .962, while SELS to learn scored .979. In general, a score of $\alpha \geq 0.9$ is regarded as excellent.

Evidence of the rationality of experiments related to the research methodology and statistics was reported. The reliability for each of the subscales extended between .777 and .806, with *experiences in research methodology*, .777, and *experiences in statistics*, .78, both regarded as acceptable. The reliability of *overall experiences* was .806, which is regarded as good.
Representing the anxiety variable, the *STARS* instrument indicated that the reliability for each of the components fluctuated from .784 to .962 (acceptable to excellent). In fact, *SITSTATS*

scored .952 (excellent) as a value of Cronbach's Alpha ("Test and Class Anxiety" .913 [excellent], "Interpretation Anxiety" .909 [excellent], "Fear of Asking for Help" .812 [good]) while STASTAS scored .956 [excellent] ("Worth of Statistics" .925 [excellent], "Computational Self-Concept" .872 [good], and "Fear of Statistics" monitors .784 [acceptable]). The validity evidence of *STARS* to other variables was reported as .962 [excellent].

Table 7.9: Results of Cronbach's Alpha of test instruments

Variables			No	UCT		UWC		Both Universities	
				Cronb.α	Cases	Cronb.α	Cases	Cronb.α	Cases
A. Experiences			6	.773	132	.820	154	.806	286
1	Research methodology		3	.802	133	.758	154	.777	287
2	Statistics		3	.729	149	.816	156	.780	305
B. STARS			51	.949	128	.965	153	.962	281
1	Situations with to Stats		23	.948	134	.953	155	.952	289
	1.1	Test	8	.927	140	.901	156	.913	296
	1.2	Interpretation	11	.897	144	.912	155	.909	299
	1.3	Ask for help	4	.798	147	.816	155	.812	302
2	Statements Stats		28	.936	143	.962	154	.956	297
	2.1	Worth	16	.892	147	.937	155	.925	302
	2.2	Teacher	5	.758	147	.795	155	.784	302
	2.3	Self-concept	7	.822	146	.888	156	.872	302
C. SATS			36	.835	125	.876	156	.861	281
1	Affect-Feelings		6	.543	148	.661	156	.611	304
2	Cognitive competence		6	.532	150	.613	156	.580	306
3	Value-Attitudes		9	.567	141	.711	156	.653	297
4	Difficulty-Attitudes		7	.604	139	.707	156	.665	295
5	Interest		4	.853	149	.884	156	.874	305
6	Effort		4	.889	149	.904	156	.897	305
D. Social support			12	.933	146	.929	156	.930	302
1	Significant others		4	.856	149	.837	156	.846	306
2	Family members		4	.899	150	.883	156	.890	307
3	Friends		4	.917	146	.875	156	.895	303
E. Current Self-efficacy			14	.959	145	.961	156	.962	301
F. Self-efficacy to learn			14	.974	148	.980	156	.979	303

Considering the independent variable attitudes, it was reported to have strong concurrent validity with the Statistics Attitude Survey. In this section, the Cronbach's Alpha of *SATS* components was classified between .58 and .897. Each of subscales was reliable with Cronbach's Alpha scores of .611 for "Affect", .58 for "Cognitive competence", .653 for

"Value", .665 for "Difficulty", .874 for "Interest" and .897 for "Effort" (Wise, 1985). The Cronbach's Alpha coefficient reported the reliability of *SATS* as .861.

Regarding the independent variable *social support*, the MSPSS (Zimet *et al.*, 1990) was applied. *Support from "significant others"* scored .846, *support from "family members"*, .890, and *support from "friends"*, .895 [all good]. The instrument was reliable with a Cronbach's Alpha coefficient of .930 [excellent] reported for the social support.

7.4. Comparison analysis

7.4.1. Comparison of each independent variable across Universities

The comparison of variables utilises cross tabulation (Coleman, 2017). Chi-square, Phi and Cramer's V are applied to test the relationship among variables. In this current study, all the independent variables were tested against the variable, *academic institution*. Each of these variables could comprise two or more categories. Chi-square (χ^2) was used to test the significance between the variables. In addition, Phi and Cramer's V were executed to measure the strength between the variables. These tests match the observed incidences, that occur in each one of the groups, with the values that would be expected if there were no connotation between the two variables being measured (Israel, 2009). Ultimately, the difference between the variables is significant if the P-value is less than 0.05 (<0.05), indicating that there is an association between these, across universities. It is constructed on a cross tabulation table, with cases classified according to the categories in each variable, for example, male/female.

7.4.1.1. Background information on both universities

Each of variables was tested. *Gender* revealed a significant association in the academic institution. The proportion of males is greater at UCT, compared to UWC, which is significantly different to the proportion of males; therefore, there was an connotation between *gender* and *academic institution*. This result, χ^2 (1, n = 307) = 20.59, n = 307; df = 1, p = .000, confirmed the information provided in the table of cross-tabulation.

Regarding the percentage of females or males among postgraduate students at both Universities, according to Table 7.10, females scored only 23.2% at UCT, while the male group represented 51.3% at UWC. Therefore, more than half (63.8%) represented the male group at both Universities, and there was a relationship between the gender and the academic institution variables. Meanwhile the P-value (.000) is lesser than the significance level (.05), the null hypothesis could not be accepted; therefore, a relationship existed between gender variable and the academic institutions variable. Applying this approach in the study was suitable because the sampling technique was simple random sampling, the variables under study were clear-cut, and the predictable occurrence count was greater than 35.87 in each cell of the contingency table. The Phi coefficient = .27, represented the effect size, which is a correlation coefficient that ranged from 0 to 1, with higher values indicating a stronger connotation between the two variables, taking into account the degrees of freedom. In this case of association, the phi =.27, which represented a fairly medium effect, based on Cohen's (1988) standards of .10 for small effect, .30 for medium effect and .50 for large effect.

Concerning age group and the academic institution, there was a significant and weak association between them (χ^2 = 11.22, n = 307; df = 3, p = .011. P = .011) which revealed a statistically substantial relationship. This implies that the proportion of students in some age groups at UCT is significantly different from the proportion of students in the similar age group at UWC. The ratio registered in age group 20-25 was 21.9% at UCT, while only 12.2% was registered in the same category at UWC. Similarly, 5.3% of students at UCT were in the age group 41+, whereas 14.7% was registered at UWC. However, Cramer's V = .19 proved a small effect size. In addition, the footnote in the chi-square tests table indicated that 0 cells (.0%) have an expected count of less than 5, which implies that the assumption was not violated, as all expected cell sizes were greater than 15.25; therefore, an association existed between age groups and academic institutions, and the environment setting could be a possible explanation for this result.

With regard to the ethnic group variable, the differences in frequencies and proportions were observed in all categories across universities. African Blacks represented the highest, with 49% at UCT and 70.5% at UWC, followed by Whites, with 32.5% at UCT and 3.8% at UWC, the smallest was observed in the Coloured group, with 22.4% at UWC and only 9.3% at UCT.

Table 7.10: Description and Chi-square of individual characteristics at both universities

Characteristics	UCT		UWC		Total		X^2	P-value
	N	%	N	%	N	%		
Gender							20.588	.000
Male	116	76.8	80	51.3	196	63.8		
Female	35	23.2	76	48.7	111	36.2		
Age groups							11.22	.011
20-25	33	21.9	19	12.2	52	16.9		
26-30	65	43	64	41	129	42		
31-40	45	29.8	50	32.1	95	30.9		
41 and +	8	5.3	23	14.7	31	10.1		
Ethnic groups							53.858	.000
African	74	49	110	70.5	184	59.9		
Coloured	14	9.3	35	22.4	49	16		
Indian	14	9.3	5	3.2	19	6.2		
White	49	32.5	6	3.8	55	17.9		
Total	151	100	156	100	307	100		
Type of study							.323	.570
Full time	141	94	143	91.7	284	92.8		
Part time	9	6	13	8.3	22	7.2		
Total	150	100	156	100	306	100		
Marital status							1.639	.201
Single	105	70	98	63.2	203	66.6		
Married	32	21.3	50	32.3	82	26.9		
Divorced	2	1.3	1	0.6	3	1		
Widow	1	0.7	1	0.6	2	0.7		
Cohabiting	10	6.7	5	1.6	15	4.9		
Total	150	100	155	100	305	100		
Student status							.267	.875
South African	73	49	78	50	151	49.5		
African	60	40.3	64	41	124	40.7		
Non-African	16	10.7	14	9	30	9.8		
Total	149	100	156	100	305	100		
Postgrad.							.119	.731
Master	93	62.8	94	60.3	187	61.5		
PhD	48	32.4	57	36.5	105	34.5		
Post-Doc	7	4.7	5	3.2	12	3.9		
Total	148	100	156	100	304	100		

The differences across ethnic groups are quite substantial, indicating a statistical significant difference (χ^2 = 53.858, n = 307; df = 3, p= .000). In addition, the effect size for this finding was substantial, with Cramer's V = .42. The association between ethnic groups and academic institutions could be accentuated with the level of income that determines the living areas surrounding the settings.

Similarly, no violation of the assumption was established, as all the expected cell sizes were greater than 9.35.

Marital status, student status, type of study and postgraduate programmes were not associated with academic institutions, as illustrated in Table 7.10; therefore, the difference observed in these variables were not explained by the manipulation, or the influence of the academic institutions.

7.4.1.2. Comparison of experience components across universities

A "Chi-square test for independence" was applied to detect the academic institutions' influence on each of the experience components. Concerning the association between *"experiences in research methodology"* and the academic institution, the results indicated a negative statistical significance at the alpha level of .05. In fact, χ^2 (2, n = 307) = 4.982, p = .083, revealing no significant association between both variables (see Table 7.11).

Table 7.11: Chi-square test for independence of experiences components

Characteristics	UCT		UWC		Total		X^2	P-value	Cramer V
	N	%	N	%	N	%			
ExpRmeth							4.982	.083	.127
Bad	3	2	8	5,1	11	3,6			
Average	36	23.8	49	31.4	85	27.68			
Good	112	74.2	99	63.5	211	68.73			
Total	151	100	156	100	307	100			
Exp Stats							5.58	.061	.135
Bad	10	6,6	22	14,1	32	10,42			
Average	60	39.6	65	41.7	125	40.72			
Good	81	53.6	69	44.2	150	48.86			
Total	151	100	156	100	307	100			
Experiences							3.899	.142	.113
Bad	2	1,3	7	4,5	9	2,93			
Average	47	31.1	56	35.9	103	33.55			
Good	102	67.5	93	59.6	195	63.52			
Total	151	100	156	100	307	100			

Regarding the "*experiences in statistics"* component, the outcomes exposed that there was no statistically important connection between this component and the academic institution, with χ^2 (2, n = 307) = 5.580, p = .061, and a Cramer V result of p = .135. Additionally, a "Chi-square test for independence" was completed to investigate the link between the *overall* experience component and the academic institution. The findings revealed that χ^2 (2, n = 307) = 3.899, p = .142 with Cramer V, p = .113 (see Table 7.11). Many factors should be considered, as gaining experience in a specific subject does not relate, automatically, to an academic institution. During the learning process, different situations arise when executing a task, such as: an individual learns by doing (for example, reading an article); by discovering new facts; participation in group activity; or by sharing knowledge.

7.4.1.3. Comparison of STARS components across universities

Regarding the STARS components, the STASTATS and overall STARS presented a significant difference across universities, as illustrated in Table 7.12. Specifically, a "Chi-square test for independence" demonstrated that the connection between STASTATS and academic institution was statistically meaningful, where the probability of the chi-square test statistic χ^2 (2, n = 307) = 15.622, was p = .000, less than the alpha level of significance of 0.05; therefore, the null hypothesis cannot be accepted.

Table 7.12: Chi-square test for independence of STARS components across universities

Characteristics	UCT		UWC		Total		X^2	P-value	Cramer V
	N	%	N	%	N	%			
STARS							13.17	.001	.207
Low	123	81.5	99	63.5	222	72.31			
Moderate	26	17.2	49	31.4	75	24.43			
High	2	1.3	8	5.1	10	3.26			
Total	151	100	156	100	307	100			
SITSTATS							5.513	.064	.134
Low	95	62.5	78	50	173	56.35			
Moderate	48	36.8	64	41	112	36.48			
High	8	5.3	14	9	22	7.17			
Total	151	100	156	100	307	100			
STASTATS							15.622	.000	.226
Low	133	88.1	112	71.8	245	79.8			
Moderate	17	11.2	32	20.5	49	15.96			
High	1	0.7	12	7.7	13	4.23			
Total	151	100	156	100	307	100			

The correlation coefficient, Cramer's V = .23, was low, indicating the effect size for the relationship. The low impact of the academic institution could explain the variation observed in STASTATS, across universities, as 0 cells (0%) expected a count less than 5. The minimum expected count was 6.39 on the contingency table.

For the overall STARS component, a similar "Chi-square test for independence" proved χ^2 (2, n = 307) = 13.170, p = .001. The P-value (.001) was less than the significance level (.05); therefore, the null hypothesis was rejected, indicating a relationship between overall STARS components and the academic institutions. Cramer's V = .21 revealed that the relationship was weak with a small effect size. Applying this approach in this current study was appropriate, despite the fact that 1 cell (16.7%) expected a count of less than 5. The minimum expected count was 4.92. However, a "Chi-square test for independence" between the academic institutions and SITSTATS, as illustrated in Table 7.12, revealed no significant association. Their level of significance p = .064 was greater than .05, indicating an acceptance of the null hypothesis. External factors might better explain the change observed in the SITSTATS. The SITSTATS and academic institutions are independent variables.

7.4.1.4. Comparison of SATS components across universities

A comparison was done for each of the SATS components, using a "Chi-square test for independence", to verify the association with academic institutions. In fact, only "e*ffort"* indicated a positive result. There was a statistically noteworthy association between "e*ffort"* and the academic institution (x^2 = 6.175, n = 307; df = 2, p =.046), as displayed in Table 7.13. However, students with a low positive attitude were most likely at UWC (17.9%), compared to those recorded at UCT (9.3%). In addition, 19.9% of the respondents registered in moderate positive attitude at UCT, as opposed to 13.5% registered in UWC, as illustrated in Table 7.13**.** As the category of positive attitude improved from low to moderate attitude, the percentage of students increased at UCT as well, while it decreased at UWC.

Table 7.13: Chi-square test for Independence of SATS components across universities

Characteristics	UCT		UWC		Total		X^2	P-value	Cramer V
	N	%	N	%	N	%			
SATS							2.539	.288	.091
Lowest	19	12.6	30	19.2	49	15.96			
Moderate	94	62.3	89	57.1	183	59.61			
Highest	38	25.2	37	23.7	75	24.43			
Total	151	100	156	100	307	100			
Affect							.471	.794	.039
Lowest	68	45	74	47.4	142	46.25			
Moderate	52	34.4	48	30.8	100	32.57			
Highest	31	20.5	34	21.8	65	21.17			
Total	151	100	156	100	307	100			
Cognitive com.							4.088	.133	.115
Lowest	66	43.7	79	50.6	145	47.23			
Moderate	60	39.7	45	28.8	105	34.2			
Highest	25	16.6	32	20.5	57	18.57			
Total	151	100	156	100	307	100			
Value							1.918	.39	.079
Lowest	98	64.9	98	62.8	196	63.84			
Moderate	40	26.5	37	23.7	77	25.08			
Highest	13	8.6	21	13.5	34	11.07			
Total	151	100	156	100	307	100			
Difficulty							.824	.655	.052
Lowest	31	20.5	38	24.4	69	22.47			
Moderate	70	46.4	72	46.2	142	46.25			
Highest	50	33.1	46	29.8	96	31.27			
Total	151	100	156	100	307	100			
Interest							5.031	.081	.128
Lowest	11	7.3	22	14.1	33	10.75			
Moderate	19	12.6	25	16	44	14.33			
Highest	121	80.1	109	69.9	230	74.92			
Total	151	100	156	100	307	100			
Effort							6.175	.046	.142
Lowest	14	9.3	28	17.9	42	13.68			
Moderate	30	19.9	21	13.5	51	16.61			
Highest	107	70.9	107	68.6	214	69.71			
Total	151	100	156	100	307	100			

Despite the significant relationship between "*effort"* and academic institutions, a Cramer's V = .14 revealed a small effect size, according to the standard (Gravetter & Wallnau, 2004). However, no violation of the assumption was found, as 0 cells (0%) expected a count of less than 5. The minimum expected count was 20.66.

The results of the analysis using a "Chi-square test for independence" between academic institutions and each of the following components of SATS, namely, "*affect*", "*cognitive competence*", "*value*", "*difficulty*", "*interest*" and *overall* SATS, indicated no significant association, as presented in Table 7.13. Their level of significance p was greater than .05, indicating a rejection of the null hypothesis. External factors, other than academic institutions, might better explain the change observed in these SATS components.

7.4.1.5. Comparison of social support across universities

Social support comprises four subscales, namely, support from *"significant others"*, *"family members"*, *"friends" and overall* social support. Each addresses a different source of support. Based on Table 7.14, support from "*friends*" and *overall* social support presented differences in scores across universities. Regarding support from "*friends*", UCT students tended to receive more "*friend*" support, compared to UWC students. In the *disagree* category, only 4.6% at UCT, as opposed to 11.5% at UWC, revealed a little lack in social cohesion among students. The same trend was observed in the *neutral* category. Surprisingly, students in the *agree* category registered the highest frequency and percentage, namely, 123 (81.5%) at UCT and 111 (71.2%) at UWC. Table 7.14 illustrates χ^2 (2, n = 307) = 6.126, p = .047. Subsequently, the P-value (.047) was less than the meaning level (.05); therefore, the null hypothesis could not be accepted. However, there was a significant association between support from *"friends"* and academic institutions. Also, Cramer's V = .14 indicated a very small effect size and the minimum expected count was 12.30, while 0 cells (0%) expected a count less than 5.

The *overall* social support component followed a different trend, as a greater number of students in filled the *neutral* (15.2%), and agree (80.8%) categories at UCT, than those in the same groups (10.9%) and (78.2%) at UWC.

Table 7.14: Chi-square test for independence of social support components

Characteristics	UCT		UWC		Total		X^2	P-value	Cramer V
	N	%	N	%	N	%			
Social support							6.081	.049	.141
Disagree	6	4	17	10.9	23	7.49			
Neutral	23	15.2	17	10.9	40	13.03			
Agree	122	80.8	122	78.2	244	79.48			
Total	151	100	156	100	307	100			
Significant others							2.77	.26	.095
Disagree	11	7.3	20	12.8	31	10.1			
Neutral	25	16.6	27	17.3	52	16.94			
Agree	115	76.2	109	69.9	224	72.96			
Total	151	100	156	100	307	100			
Support Family							1.927	.413	.079
Disagree	8	5.3	14	9	22	7.17			
Neutral	26	17.2	22	14.1	48	15.63			
Agree	117	77.5	120	76.9	237	77.2			
Total	151	100	21	13.9	307	100			
Support friends							6.126	.044	.141
Disagree	7	4.6	18	11.5	25	8.14			
Neutral	21	13.9	27	17.3	48	15.63			
Agree	123	81.5	111	71.2	234	76.22			
Total	151	100	156	100	307	100			

In addition, students claiming *disagree* in receiving *social support* were greater at UWC than at UCT. A “Chi-square test for independence” demonstrated that the relationship between the *overall* social support and academic institutions was statistically significant, where the probability of the chi-square test statistic χ^2 (2, n = 307) = 6.081, p = .049 (less than the alpha level of significance of .05). This association was very weak, with a p-value equal to the upper limit of significance. Additionally, the effect size for this finding was very small (Cramer's V=.14). Similarly, the minimum expected count was 11.31, but 0 cells (0%) expected a count less than 5.

Support from *"family members"* and "*significance others"* were not statistically associated to the academic institution, as illustrated in Table 7.14. Some external events might better explain the difference observed in these relevant variables.

7.4.1.6 Self-efficacy to learn

An "independent-samples t-test" was engaged to compare the self-efficacy to learn statistics beliefs scores (SELS) for UCT and UWC. The results are categorised in Tables 7.15a,b. There was no substantial change in the ratings for UCT (M = .928, SD = .802) and UWC (M = .928, SD = .840; t (305) = .000, p = 1.00, two-tailed). The greatness of the variances in the means (mean difference = .00002, 95% CI: –.18463 to .18467) was very small (eta squared = .00). The academic institution did not explain the variance in self-efficacy to learn statistics.

Table 7.15a: Group statistics

Academic institutions		N	Mean	Std. Deviation	Std. Error Mean
SELS	UCT	151	.9284	.80243	.06530
	UWC	156	.9284	.84048	.06729

Table 7.15b: Independent samples test

		Levene's Test for Equality		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% C. Interval of the Difference	
									Lower	Upper
SELS	Equal variances assumed	.895	.345	.000	305	1.000	.00002	.09384	-.18463	.18467
	Equal variances not assumed			.000	304.943	1.000	.00002	.09377	.18449	.18454

7.4.2. Comparison effect of independent variables on the SELS across universities

The comparison of mean scores was performed using an “Independent samples t-test”, or a “One-way ANOVA test” for both universities’ data sets. However, an “Independent samples t-test” was used to compare the mean scores of the SELS beliefswith two diverse groups of participants from independent variables (gender, marital status, postgraduate programmes, type of study and STARS components).

7.4.2.1. Impact of background on the SELS across universities

An “independent-samples t-test” was performed to determine whether there were modifications in SELS scores between Masters and PhD/post-doctorate students. Inspecting a boxplot of each of these variables, there were no outliers in the data. The SELS score for each level of postgraduate programmes was approximately normally distributed, as evaluated by the rule of thumb (The population inconsistencies are equal across reactions for the group levels. If the main sample standard deviation is not greater than two, then assume that the population variances are equal). The findings present in this section are summarised below in Tables 7.16a, b. There was no destruction of homogeneity of variances, as the Leverne’s test for equality of variances revealed that p = .291; therefore, equal variances were assumed.

Table 7.16a: Group statistics

		N	Mean	Std. Deviation	Std. Error Mean
SELS	master	187	.843	.829	.060
	PhD & Post-doc	117	.601	.755	.069
	Male	196	.753	.809	.058
	Female	111	.725	.810	.077
	Full time	284	.748	.799	.047
	Part time	22	.703	.944	.201
	Single	208	.773	.782	.054
	Married	97	.660	.859	.087

Remarkably, masters students performed more in the SELS scores (M = .843, SD = .829), compared to PhD/post-doctorate students (M = .601, SD = .756).

However, the results indicate a noteworthy change in their mean scores. The difference in means was M = .242, 95% CI: [–.056, .428], t (302) = 2.562, p = .011, two-tailed. The difference was very small (Eta squared =.02).

In addition, an “independent-samples test” was performed to contrast the SELS scores for men and women. There was no major difference in the ratings for men (M = .753, SD = .809) and women (M = .725, SD = .810); t (305) = .283, p = .777 (two-tailed). Therefore, the difference in the means (mean difference = .27, 95% CI: [-.162 to .216]) was insignificant (eta squared = .0002).

Table 7.16b: Independent samples test

		Levene's Test		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% C.I. of the Difference	
									Lower	Upper
SELS - Postgraduate programme	Equal variances assumed	1.118	.291	2.562	302	.011	.242	.095	.056	.428
	Equal variances not assumed			2.617	263.425	.009	.242	.092	.059	.424
SELS - Gender	Equal variances assumed	.639	.425	.283	305	.777	.027	.096	-.162	.216
	Equal variances not assumed			.283	228.340	.778	.027	.096	-.162	.217
SELS - Type of study	Equal variances assumed	.058	.810	.253	304	.800	.045	.179	-.307	.398
	Equal variances not assumed			.220	23.394	.828	.045	.207	-.382	.473
SELS - Marital status	Equal variances assumed	.673	.413	1.143	303	.254	.113	.099	-.082	.309
	Equal variances not assumed			1.105	172.535	.271	.113	.103	-.089	.316

Subsequently, similar test was investigated for the type of study. Using an “independent-samples t-test” to assess whether there was a major modification in means of the SELS ratings, between full-time and part-time students. There was no valuable difference in the ratings for full-time (M = .748, SD = .799) and part-time students (M = .703, SD = .944); t (304) = .253, p = .800, two-tailed. The difference in the means (mean variance = .045, 95% CI: [-.307 to .398]) was insignificant (eta squared = .0002), as the means were relatively similar.

Concerning marital status, the t-test was performed to explore the SELS beliefs ratings for single/divorced/widows and married/cohabiting students. The findings revealed that there was no statistically important variation in means scores for single/divorced/widows students (M = .773, SD = .782), and married/cohabiting students (M = .660, SD = .859). The mean difference = .113, 95% CI: [-.82 to .309], t (303) = 1.143, p = .254, two-tailed. The change in the means was irrelevant (eta squared = .004), which indicated a tiny variance in SELS outcomes for marital status. Definitely, according to background variables, only postgraduate programmes revealed a substantial difference between its groups (Master, and PhD/Post-doctorate).

Table 7.16c Test of homogeneity of variances

Variables	Levene Statistic	df1	df2	Sig.
Age group	1.803	3	303	.147
Ethnic	1.365	3	303	.253
Student status	.433	2	302	.649

Additional analyses were conducted, using a "One-way ANOVA test", to compare the mean difference for the background variables with more than two groups. These variables were *age group*, *ethnic group* and *student status (see Tables 7.16c,d)*. A "One-way ANOVA test" was performed to examine the influence of *age* on the levels of SELS beliefs. The graduate students were separated into four clusters, giving their ages (cluster 1: 20-25yrs; cluster 2: 26 to 30yrs; cluster 3: 31 to 40yrs; cluster 4: 41yrs and above). The significance value for Levene's test was p = .147, greater than .05, representing no violation theory of homogeneity of variance. However, there was no statistically meaningful difference at the p < .05 level in SELS beliefs scores for the four age clusters: F (3, 303) = 1.147, p = .330.

Furthermore, a similar “One-way ANOVA test” was executed to investigate the impression of *ethnic group* on the levels of SELS beliefs. The postgraduate students were divided into four categories, according to their ethnicity (category 1: African; group 2: Coloured; category 3: Indian; category 4: White). The Levene’s test of homogeneity revealed no violation of assumption of equal variances (p = .253). There was no statistically substantial difference at the p < .05 level in SELS beliefs’ scores for the three age categories: F (3, 303) = .863, p = .460. The actual variance in mean scores between the categories represented nothing, and the effect size, calculated using eta squared, was .008.

Table 7.16d ANOVA

Variables		Sum of Squares	df	Mean Square	F	Sig.
Age group	Between Groups	2.314	3	.771	1.147	.330
	Within Groups	203.762	303	.672		
	Total	206.076	306			
Ethnic	Between Groups	1.747	3	.582	.863	.460
	Within Groups	204.330	303	.674		
	Total	206.076	306			
Student status	Between Groups	1.111	2	.555	.821	.441
	Within Groups	204.351	302	.677		
	Total	205.462	304			

Subsequently, “a One-way ANOVA test” was applied to examine the control of *student status* on the levels of SELS beliefs. The respondents were assigned to three classes, rendering to their student status (class 1: South African; class 2: African; class 3: Non-African). The homogeneity of variance, Levene’s test p = .649, revealed that the modification in the ratings was the same for each of the three classes. There was no statistically important difference at the p < .05 level in SELS beliefs' ratings for the three classes: F (2, 302) = .821, p = .441. The effect size, designed using eta squared, was .005.

7.4.2.2. STARS differences

STARS components involved SITSTATS, STASTATS and overall STARS. An "independent-samples t-test" was conducted to explore the impact of SITSTATS on levels of ability to learn statistics, as measured by the SELS (see Tables 7.17a and 7.17b). The Levene's test for fairness of variances was p = .567, greater to .05; therefore; the first line as seen in the table of independent samples test should be applied, so that equal variances can be assumed. No distortions were found in the data. The results revealed that students with low anxiety were slightly more advanced in learning outcomes, compared to those with moderate/high anxiety. There was a statistically noteworthy difference in means scores for low anxiety students (M = 4.790, SD = 1.194), and moderate/high anxiety students (M = 4.160, SD = 1.316); t (305) = 4.329, p = .000, two-tailed. The mean modification = .622, 95% CI: [.339 to .905] was moderate (eta squared = .06).

Table 7.17a: Group statistics for STARS

STARS			N	Mean	Std. Deviation	Std. Error Mean
SELS	SITSTATS	Low anx.	222	4.74	1.174	.079
		Moderate & High anxiety	85	3.93	1.378	.149
	STASTATS	Low anx.	245	4.68	1.173	.075
		Moderate & High anxiety	62	3.87	1.498	.190
	STARS	Low anx.	173	4.79	1.194	.091
		Moderate & High anxiety	134	4.16	1.316	.114

Additionally, an "independent-samples t-test" was conducted to compare the STASTATS scores for low anxiety students and moderate/high anxiety students. The Levene's test for equality of variances indicated the level of significance p = .014, implying that the assumption for equal variances was not attempted, and the second line in the table of "independent samples test" was applied. There was a statistically substantial difference in the scores for low anxiety students (M =

4.680, SD = 1.173), and moderate/high anxiety students (M = 3.870, SD = 1.498); t (305) = 3.944, p = .000, two-tailed. The differences in the means (mean difference = .807, 95% CI: [.400 to 1.214] was insignificant (eta squared = .05).

Subsequently, a similar test was conducted to identify whether there was a difference in the scores of the overall STARS component on the levels of ability to learn statistics, as restrained by the SELS. There was a statistically major change at the $p < .05$ level in the overall STARS scores for low anxiety students (M = 4.740, SD = 1.174), which was meaningfully different from moderate/high anxiety students (M = 3.930, SD = 1.378). The mean modification = .809, 95% CI: [.500 to 1.119], t (305) = 5.142, p = .000, two-tailed. The effect size was moderate (eta squared = .08).

Table 7.17b: Independent samples test STARS

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% CI Lower	95% CI Upper
SELS Mean - SITSTATS	Equal variances assumed	1.507	.220	4.329	305	.000	.622	.144	.339	.905
	Equal variances not assumed			4.275	271.308	.000	.622	.145	.336	.908
SELS Mean - STASTATS	Equal variances assumed	6.145	.014	4.558	305	.000	.807	.177	.458	1.155
	Equal variances not assumed			3.944	80.887	.000	.807	.205	.400	1.214
SELS Mean - STARS	Equal variances assumed	2.144	.144	5.142	305	.000	.809	.157	.500	1.119
	Equal variances not assumed			4.789	133.283	.000	.809	.169	.475	1.144

7.4.2.3. Experience differences

In general, student responses were distributed into three sets, according to their experience levels (set 1 = bad; set 2 = average; and set 3 = good). The comparison of the mean scores was conducted, using a "One-way ANOVA test" to compile a data set of both universities (see Table 7.18a,b,c). Regarding *experience in research methodology*, the results in Table 7.18a reveal a statistically significant difference in the means at the $p < .011$ level of SELS ratings for the three sets; $F(2, 304) = 3.848$, $p = .022$. Regardless of reaching statistical implication, the current variance in mean cuts between the ratings was small. Eta squared = .03, confirmed a small size effect. Multiple appraisals, using the Tukey HSD test, designated that the mean rating for set 2 ($M = 1.115$, $SD = .836$) was significantly different from set 3 ($M = .842$, $SD = .798$). But set 1 ($M = 1.152$, $SD = .923$) did not differ significantly from either set 2 or 3.

Table 7.18a: Test of homogeneity of variances

Variables	Levene Statistic	df1	df2	Sig.
Experience Rmeth	.564	2	304	.569
Exp. statistics	.023	2	304	.977
Experiences	1.199	2	304	.303

Subsequently, a test was directed to explore the influence of *experiences in statistics* on different ratings of the SELS scores. There was no statistically substantial difference at the $p < .05$ level in SELS ratings for the three *experiences in statistics* groups: $F(2, 304) = 1.228$, $p = .294$. The observed difference in mean scores was little and could not explain the variation that occurred in the SELS scores.

A "One-way ANOVA test" was engaged to check the impression of the *overall experience* on the levels of SELS. The results discovered that there was no statistically significant difference at the $p < .05$ level in SELS ratings for the three *overall experience* categories: $F(2, 307) = .606$, $p = .546$. Regardless of not reaching statistical significance, the actual difference in mean scores between the groups might be explained by some extraneous variables.

Table 7.18b: ANOVA experiences

Variables		Sum of Squares	df	Mean Square	F	Sig.
Exp RMeth	Between Groups	5.089	2	2.544	3.848	.022
	Within Groups	200.987	304	.661		
	Total	206.076	306			
Exp. stats	Between Groups	1.651	2	.826	1.228	.294
	Within Groups	204.425	304	.672		
	Total	206.076	306			
Experience	Between Groups	.819	2	.409	.606	.546
	Within Groups	205.257	304	.675		
	Total	206.076	306			

Table 7.18c: Multiple comparisons of experiences

Variables				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Experience R.Meth	Tukey HSD	Bad	Average	.037	.261	.989	-.577	.650
			Good	.310	.251	.435	-.282	.902
		Average	Bad	-.037	.261	.989	-.650	.577
			Good	.273	.104	.025	.027	.519
		Good	Bad	-.310	.251	.435	-.902	.282
			Average	-.273	.104	.025	-.519	-.027
Experience statistics	Tukey HSD	Bad	Average	-.168	.162	.558	-.550	.215
			Good	-.023	.160	.989	-.399	.353
		Average	Bad	.168	.162	.558	-.215	.550
			Good	.145	.099	.314	-.089	.378
		Good	Bad	.023	.160	.989	-.353	.399
			Average	-.145	.099	.314	-.378	.089
Experiences	Tukey HSD	Bad	Average	.087	.286	.950	-.586	.760
			Good	.183	.280	.790	-.477	.843
		Average	Bad	-.087	.286	.950	-.760	.586
			Good	.096	.100	.603	-.140	.332
		Good	Bad	-.183	.280	.790	-.843	.477
			Average	-.096	.100	.603	-.332	.140

7.4.2.4. SATS differences

The SATS components were "*affect*", "*cognitive competence*", "*value*", "*difficulty*", "*interest*", "*effort*" and the *overall* SATS. The student responses were divided into three groups (group 1 = low positive attitude, group 2 = moderate positive attitude and group 3 = high positive attitude). The results in this section are summarized in Tables 7.19a,b. Considering the "*affect"* component, a "One-way ANOVA test" was done to investigate the control of the "*affect"* component on levels of SELS. There was no statistically major dissimilarity at the p < .05 level in SELS cuts for the three "*affect"* groups: F (2, 307) = 1.140, p = .321.

Regarding the "*cognitive competence"* component, a "One-way ANOVA test" was lead to discover if there was a significance difference in means of the SELS ratings for the three levels of attitude in *"cognitive competence"*. The results indicated that there was no statistically meaningful difference at the p < .05 level in SELS ratings for the three "*cognitive competence"* levels: F (2, 307) = .089, p = .915.

For the "*value"* component, a "One-way ANOVA test" was conducted to measure the impact of the "value" component on levels of ability to learn statistics, as measured by the SELS beliefs. There was no statistically important modification at the p < .05 level in SELS scores for the three "*value"* groups: F (2, 307) = 1.031, p = .358.

Table 7.19a: Test of homogeneity of variances

Variables	Levene Statistic	df1	df2	Sig.
Affect	.157	2	304	.855
Cog comp	.138	2	304	.871
Value	1.991	2	304	.138
Difficulty	1.607	2	304	.202
Interest	.502	2	304	.606
Effort	.932	2	304	.395
SATS	.851	2	304	.428

A "One-way ANOVA test" was run to examine the impact of the "*difficulty"* component on levels of the SELS beliefs. The respondents were categorised into three clusters according to their level of difficulty. There was no statistically major variance at the $p < .05$ level in SELS ratings for the three "*difficulty*" clusters: F (2, 307) = 1.100, p = .334.

Furthermore, a "One-way ANOVA test" was also directed to scrutinise the impression of the "*interest*" component on levels of the SELS beliefs. The rstudents were gathered into three groups according to their degree of interest. The outcomes disclosed that there was no statistically weighty change at the $p < .05$ level in SELS scores for the three "*interest*" groups: F (2, 307) = .256, p = .774.

Table 7.19b: SATS ANOVA

Variables		Sum of Squares	df	Mean Square	F	Sig.
Affect	Between Groups	1.533	2	.767	1.140	.321
	Within Groups	204.543	304	.673		
	Total	206.076	306			
Cog comp	Between Groups	.120	2	.060	.089	.915
	Within Groups	205.956	304	.677		
	Total	206.076	306			
Value	Between Groups	1.388	2	.694	1.031	.358
	Within Groups	204.688	304	.673		
	Total	206.076	306			
Difficulty	Between Groups	1.481	2	.740	1.100	.334
	Within Groups	204.595	304	.673		
	Total	206.076	306			
Interest	Between Groups	.347	2	.173	.256	.774
	Within Groups	205.729	304	.677		
	Total	206.076	306			
Effort	Between Groups	.575	2	.287	.425	.654
	Within Groups	205.502	304	.676		
	Total	206.076	306			
SATS	Between Groups	2.233	2	1.117	1.665	.191
	Within Groups	203.843	304	.671		
	Total	206.076	306			

A "One-way ANOVA test" was performed to explore the influence of the "*effort*" component on levels of the SELS beliefs. The students were separated into three categories according to the level of their "effort". There was no statistically noteworthy difference at the $p < .05$ level in SELS scores for the three "*effort*" categories: F (2, 307) = .425, p = .654.

A "One-way ANOVA test" was completed to investigate the impression of the *overall SATS* component on levels of the SELS beliefs. The respondents were divided into three sets, according to their overall SATS. The findings presented that there was no statistically important change at the $p < .05$ level in SELS scores for the three *overall SATS* sets: $F (2, 307) = 1.665$, $p = .191$.

Surprisingly, none of the SATS components revealed a statistically significant difference in its means.

7.4.2.5. Social support differences

The social support components were support from *"significant others"*, support from *"family members"*, support from *"friends"* and *overall* social support. The student responses were divided into three groups (group 1 = disagree, group 2 = neutral and group 3 = agree).

A "One-way ANOVA test" was lead to examine the influence of the support from *"significant others"* component on levels of the SELS beliefs ratings. The respondents were divided into three categories, according to their level of support from *"significant others"* (see Tables 7.20a,b,c,d below). There was a statistically substantial difference at the $p < .05$ level in SELS scores for the three support from *"significant others"* categories: $F (2, 307) = 4.004$, $p = .019$. In addition to the statistical implication, the actual difference in mean scores between the categories was minor. The effect size, generated using eta squared, was .03 (Cohen, 1988). Multiple assessments using the Tukey HSD test indicated that the mean score for category 2 ($M = 1.218$, $SD = .912$) was expressively different from category 3 ($M = .873$, $SD = 783$). Category 1 ($M = .842$, $SD = .851$) did not differ meaningfully from either categories 2 or 3.

Table 7.20a: Test of homogeneity of variances

Variables	Levene Statistic	df1	df2	Sig.
Sig. O.	1.354	2	304	.26
Family	.186	2	304	.83
Friends	3.564	2	304	.03
Social sup.	.617	2	304	.54

Besides, a "One-way ANOVA test" was directed to explore the impact of the support from *"family members"* component on levels of the SELS beliefs ratings. The respondents were divided into three groups, according to their degree of support from *"family members"*. Results from Tables 7.20a,b,c,d indicated that there was no statistically important dissimilarity at the p < .05 level in SELS scores for the three support from *family members* groups: F (2, 307) = .185, p = .832.

Table 7.20b: Robust tests of equality of means

	Statistic[a]	df1	df2	Sig.
Welch	2.288	2	49.017	.11
Brown-Forsythe	2.577	2	78.584	.08

Furthermore, a "Oone-way ANOVA test" was shown to search the impact of the support from *"friends"* component on levels of the SELS beliefs. The respondents were alienated into three groups, according to the degree of the support from *"friends"*. Table 7.20a,b,c,d reveal that there was a statistically meaningful change at the p < .05 level in SELS scores for the three support from *"friends"* groups: F (2, 307) = 3.515, p = .031. Even with reaching statistical significance, the real difference in mean scores between the groups was small. The effect size, designed via eta squared, was .02. Post-hoc comparisons using the Tukey HSD test indicated that the mean score for Group 2 (M = 1.212, SD = 1.050) was knowingly different from Group 3 (M = .870, SD = 747). Group 1 (M = .933, SD = .900) did not differ meaningfully from either Group 2 or 3.

Moreover, a "one-way ANOVA test" was performed to investigate the impact of the *overall* social support component on levels of the SELS. The students were shared into three sets, according to the level of their *overall* social support. Table 7.20a,b,c,d present that there was no statistically main change at the p < .05 level in SELS ratings for the three *overall* social support categories: F (2, 307) = 1.566, p = .211.
However, there was a meaningful difference in means of support from "*significant others*" and from "*friends*" while support from "*family members*" and the *overall* social support did not present important difference in means.

Table 7.20c: ANOVA social support

Variables		Sum of Squares	df	Mean Square	F	Sig.
SIG. O.	Between Groups	**5.289**	**2**	**2.645**	**4.004**	**.019**
	Within Groups	200.787	304	.66		
	Total	206.076	306			
Family	Between Groups	.25	2	.125	.185	.832
	Within Groups	205.826	304	.677		
	Total	206.076	306			
Friends	Between Groups	4.658	2	2.329	3.515	.031
	Within Groups	201.418	304	.663		
	Total	206.076	306			
Social sup	Between Groups	2.101	2	1.051	1.566	.211
	Within Groups	203.975	304	.671		
	Total	206.076	306			

Table 7.20d: Post hoc comparisons social support

Variables				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Sig. O.	Tukey HSD	Disagree	Neutral	-.376	.184	.105	-.810	.058
			Agree	-.031	.156	.979	-.398	.336
		Neutral	Disagree	.376	.184	.105	-.058	.810
			Agree	.345	.125	.017	.051	.640
		Agree	Disagree	.031	.156	.979	-.336	.398
			Neutral	-.345	.125	.017	-.640	-.051
Family	Tukey HSD	Disagree	Neutral	-.127	.212	.820	-.626	.372
			Agree	-.076	.183	.909	-.508	.356
		Neutral	Disagree	.127	.212	.820	-.372	.626
			Agree	.051	.130	.919	-.256	.358
		Agree	Disagree	.076	.183	.909	-.356	.508
			Neutral	-.051	.130	.919	-.358	.256
Friends	Tukey HSD	Disagree	Neutral	-.278	.201	.349	-.751	.194
			Agree	.064	.171	.927	-.340	.467
		Neutral	Disagree	.278	.201	.349	-.194	.751
			Agree	.342	.129	.023	.038	.646
		Agree	Disagree	-.064	.171	.927	-.467	.340
			Neutral	-.342	.129	.023	-.646	-.038
Social sup	Tukey HSD	Disagree	Neutral	-.318	.214	.300	-.823	.187
			Agree	-.090	.179	.869	-.511	.331
		Neutral	Disagree	.318	.214	.300	-.187	.823
			Agree	.228	.140	.235	-.101	.557
		Agree	Disagree	.090	.179	.869	-.331	.511
			Neutral	-.228	.140	.235	-.557	.101

7.5. Multivariate analysis: Ordinal Regression Model

Constructing an "Ordinal Regression" Model involves numerous judgments. Firstly, there is a need to recognise the ordinal outcome (dependent) variable. Secondly, choose which prognosticators to practice for the slope coefficients of the model. Finally, choose which link function provides good fits for the data. In ordinal regression, the link function is a conversion of the aggregate probabilities of the ordered dependent variable that permits for approximation of the model. The SPSS package was applied in the analysis (IBM, 2010; Pallant, 2013). To choose a link function, it is helpful to examine the dispersal of the values for the outcome variable. The histogram for the dependent variables reveals the distribution of categories of the overall students' self-efficacy to learn statistics. According to Figure 7.1, the majority of values are in the higher categories more likely, mainly categories 2 (A fair confidence), and 3 (much confidence). For this reason, the Complementary log-log link function was applied, given that the higher outcome categories were more probable. This function is the inverse of the negative log-log function. This function is suggested when the likelihood of a upper category is great. Mathematically, complementary log-log is p (z) = log (– log (1 – z)).

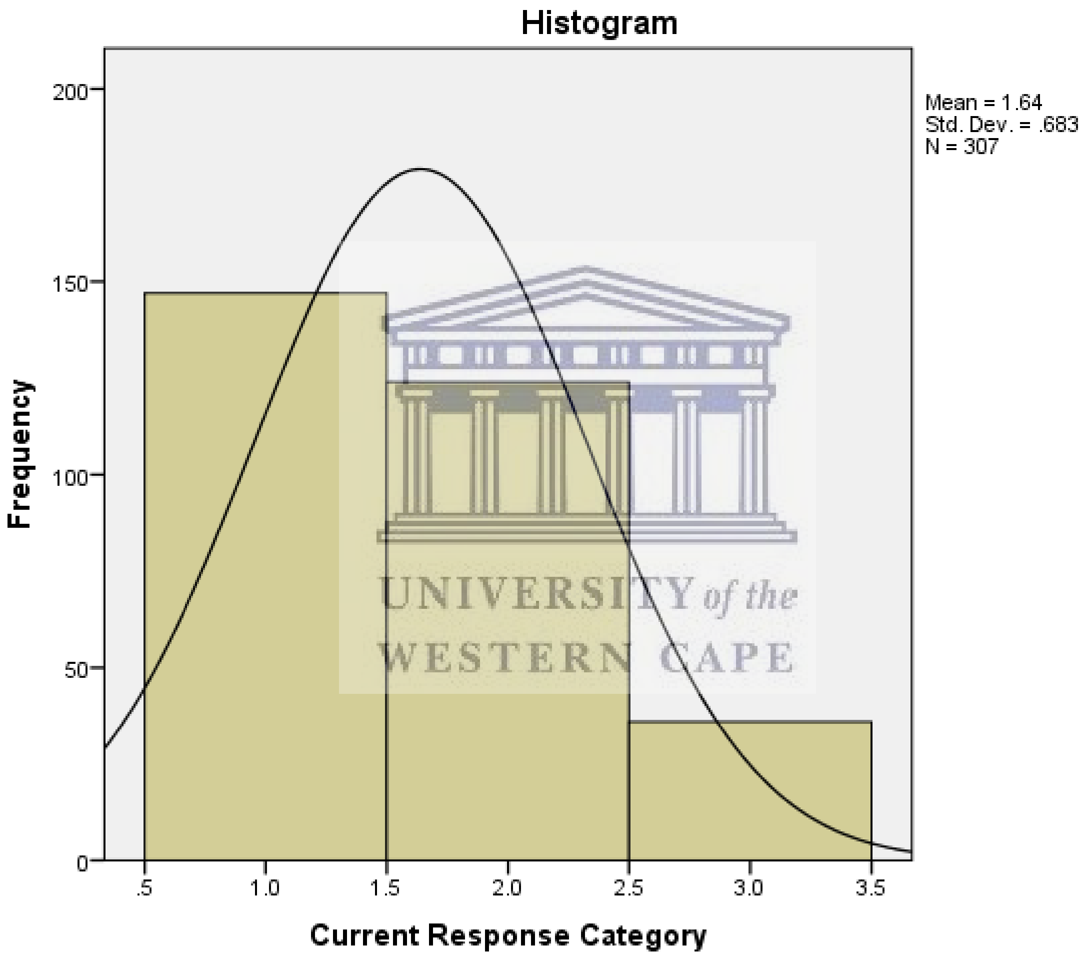


Figure 7.1: Distribution of students' self-efficacy to learn statistics in both universities

7.5.1. Predictive value of the model

The model provides suitable expectations, and the model correct data is scanned in Table 7.21. The important chi-square statistic designates that the model generates a substantial perfection over the baseline intercept-only model. This essentially indicates that the model provides improved estimates, than just guessed, founded on the bordering likelihoods for the outcome categories.

Table 7.21: Model fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	472.838			
Final	297.460	175.378	40	.000

Link function: Complementary Log-log.

7.5.2. Tests for goodness-of-fit

Table 7.22 comprises Pearson's chi-square statistic for the model, and another chi-square statistic, built on the nonconformity. These indicators are proposed to test whether the observed records are unpredictable with the fixed model. The present model fitted fine, the observed and expected cell counts were comparable, the value of each statistic was small, and the observed significance level was great. The null hypothesis for the model fits is rejected if the observed significance level for the goodness-of-fit statistics is small. Good models have large observed significance levels. In Table 7.22, the goodness-of-fit measures have large observed significance levels; therefore, the model fits.

Table 7.22: Goodness of fit with scale model

Test	Chi-Square	df	Sig.
Pearson	435.783	444	.601
Deviance	396.044	444	.950

Link function: Complementary Log-log

7.5.3. Pseudo R-squared measures

In the Linear Regression Model, the measurement of determination, R^2, recapitulates the amount of change in the dependent variable, connected with the prognosticator variables, with greater R^2 values, showing that more of the discrepancy is explained by the model. For regression models with a categorical dependent variable, it is not conceivable to calculate a particular R^2 statistic that has all of the features of R^2 in the Linear Regression Model; therefore these estimates are worked out in its place. The subsequent approaches are applied to assess the measurement of determination. Cox and Snell's (1989) (R^2) is based on the log likelihood for the model, compared to the log likelihood for a baseline model. However, with categorical outcomes, it has a theoretical maximum value of less than 1, even for a "perfect" model. Nagelkerke/Cragg & Uhler's (1991) (R^2) is an adjusted version of the Cox & Snell's (1989) that adjusts the scale of the statistic to cover the full range from 0 to 1. McFadden's (1974) (R^2) is another version, based on the log-likelihood kernels for the intercept-only model and the full estimated model. The model with the largest statistic is "best" according to these procedures. According to Table 7.23, these coefficients, which indicate the fitting model, are good, based on these approaches, while Nagelkerke (R^2) is the best with 60%.

Table 7.23: Pseudo R-square

Cox and Snell	.514
Nagelkerke	.600
McFadden	.371

Link function: Complementary Log-log

7.5.4. Test of parallel lines

The test of parallel lines assesses whether the statement that the parameters are approximately the same for all categories is unbiased. This test confronts the estimated model with one set of coefficients for all categories, to a model with a separate set of coefficients for each category. Table 7.24 indicates that the assumption is credible for this study, where the observed significant level is large (p= .670 greater than .05). The null hypothesis states that the slope coefficients are the same across the response categories.

Table 7.24: Test of parallel lines

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	297.460			
General	261.889[b]	35.571[c]	40	.670

Link function: Complementary Log-log

7.5.5. Parameter estimates

The parameter estimates are illustrated in Table 7.25. In addition, it recapitulates the effect of each predictor. The sign of the coefficients for covariates, and the relative values of the coefficients for factor levels, can provide significant understandings into the influences of the predictors in the model. For covariates, positive (negative) coefficients indicate positive (inverse) relationships between predictors and outcome. An increasing value of a covariate with a positive coefficient matches up to an increasing likelihood of being in one of the 'higher' collective outcome categories. For factors, a factor level with a greater coefficient reveals a greater possibility of being in one of the 'higher' increasing outcome categories. The sign of a coefficient for a factor level is dependent on that factor level's effect, relative to the reference categories.

The implication of the test for *ethnic groups* was less than 0.05 (p= .046), suggesting that its observed effect was not due to chance. Since its coefficient .844 was positive and high, student *ethnic groups* have a positive relationship with SELS beliefs, so does the probability of being in one of the ethnic groups of account status. Additionally, *marital status* displays a significance of the test of p= 039, with a positive estimate .466, emphasising that, if student is married or cohabiting, the probability of learning statistics increases its status. In addition, the *postgraduate programmes* covariate has a similar effect, and estimates a positive (.612). By contrast, *gender, age groups, student status, type of study* and *department* add little to the model. E*xperience in research methodology* is not significant, while for *familiarize the students with experiences in statistics*, is significant (p= .006). Since its coefficient is negative (-.366), as *experiences in statistics increases,* the likelihood of being in one of the higher aggregate outcome categories decreases.

The factor "*effort"* reveals that *engaged* and *active students to apply statistical procedures* develop a suitable environment for its capabilities to learn statistics (p= .024). Additionally, the coefficient of the factor "*effort"* (-.298) is negative, indicating that as students decrease in effort to improve their ability, the likelihood of being in one of the higher aggregate outcome categories increases. Although, the slight significance of the test for *factor "test"* is p= .055, the *factor "test"* appears to be a stimulator, with its positive coefficient (.282). The participation of the students to tests, improves their self-efficacy performance to learn statistics, while an increase in the factor *"test"*, increases the possibility of being in one of the higher increasing outcome categories. However, various factors, such as "*interpretation of concepts" or outcomes, "ask for help", "worth of statistics", "Computational self-concept", "fear of statistics"* monitors, *"affect", "cognitive competence", "value", "difficulty", "interest"*, support from *"significant others", "family members"* and support from *"friends"* are not significant. It is worth keeping such variables in the model, since the small effects of each category accumulate and provide useful information to the model.

Table 7.25: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[SelfEffAbsMeanOrd = 1]	.378	.923	.168	1	.682	-1.431	2.187
	[SelfEffAbsMeanOrd = 2]	1.92	.929	4.265	1	.039	.098	3.741
Location	Exp in research method	.059	.131	.206	1	.65	-.197	.315
	Exp in statistics	-.366	.132	7.687	1	.006	-.626	-.107
	Test of statistics	.282	.147	3.668	1	.055	-.007	.57
	Interpretation stats	-.22	.174	1.599	1	.206	-.56	.121
	Ask for help	.09	.157	.329	1	.566	-.218	.399
	Worth of statistics	-.135	.238	.324	1	.569	-.602	.331
	Fear of statistics	.295	.192	2.36	1	.124	-.081	.671
	Comput. Self-concept	-.089	.172	.267	1	.605	-.427	.249
	Affect	-.086	.143	.361	1	.548	-.367	.195
	Cognitive competence	-.238	.156	2.33	1	.127	-.543	.068
	Value	.048	.138	.119	1	.73	-.223	.318
	Difficulty	-.014	.102	.02	1	.888	-.215	.186
	Interest	.18	.123	2.151	1	.143	-.061	.421
	Effort	-.298	.132	5.095	1	.024	-.556	-.039
	Significant others	.116	.135	.743	1	.389	-.148	.38
	Family members	.091	.144	.394	1	.53	-.192	.374
	Friends	-.209	.131	2.568	1	.109	-.465	.047
	Postgraduate programme	.612	.208	8.624	1	.003	.204	1.02
	Marital status	.466	.225	4.28	1	.039	.025	.907
	Age gp1: 20-25	.28	.429	.425	1	.514	-.562	1.122
	Agegp=2: 26-30	.049	.352	.019	1	.89	-.641	.738
	Agegp=3: 31-40	.064	.313	.042	1	.837	-.55	.679
	Gender	0	.191	0	1	.999	-.373	.374
	Ethnic gp: African	.09	.286	.099	1	.753	-.471	.652
	Ethnic gp: Coloured	-.316	.304	1.084	1	.298	-.912	.279
	Ethnic gp: Indian	.844	.422	3.996	1	.046	.017	1.671
	Student status: S. Afric.	-.263	.343	.588	1	.443	-.936	.41
	Student status: African	-.539	.328	2.704	1	.1	-1.181	.103

	Full-time	-.095	.37	.066	1	.798	-.821	.631
	Applied Sciences	-.386	.986	.154	1	.695	-2.319	1.546
	Business & managemen	.227	.928	.06	1	.807	-1.593	2.046
	Education	-1.636	.982	2.776	1	.096	-3.561	.289
	Engineering	2.232	1.173	3.619	1	.057	-.068	4.532
	Health & Wellness Sc.	.933	.794	1.379	1	.24	-.624	2.489
	Art & Humanity	.593	.781	.577	1	.448	-.938	2.125
	Economic & managemen	.348	.793	.193	1	.661	-1.207	1.903
	Com.Health science	.437	.811	.29	1	.591	-1.154	2.027
	Natural Science	.603	.731	.68	1	.41	-.83	2.036
	[A9=11]	.299	.746	.161	1	.688	-1.162	1.76
	[A9=12]	-2.317	0		1		-2.317	-2.317

Link function: Complementary Log-log.

Like logistic and linear regression modelling techniques, the assumption of parsimony was applicable to the construction of the ordinal regression model. However, many link functions were applicable to construct the candidate models, and to choose the best model. Much time and energy was dedicated to emerging potential models, checking the model assumptions, assuring the model goodness-of-fit, and, consequently, selecting the best model for the study. Therefore, the search for the candidate model, using the Logit link is reported below.

7.5.6. Predictive value of the model

The complete model, using the Logit link function inspected 243 of the 307 questionnaires, and excluded 64 questionnaires, as a consequence of having a ‘not applicable’ rating, or at least one item with missing data. The complete model, containing all the items indicated some exciting results. The significant chi-square statistic indicated that the model provided improved estimates, instead of predicting, based on the likelihoods for the outcome categories. Table 7.26 provides model-fitting information with p = .001.

Table 7.26: Model fitting information

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	472.838			
Final	399.747	73.091	39	.001

Link function: Logit

7.5.7. Tests for goodness-of-fit

Pearson's chi-square statistic for the model, and another chi-square statistic based on the deviance are described in Table 7.27. Given that the current model fitted well, the observed and expected cell counts were similar, with a small value, and the observed significance level was large. In fact, both goodness-of-fit measures have large observed significance levels; therefore, it shows that the model fits.

Table 7.27: Goodness of fit with scale model

Test	Chi-Square	df	Sig.
Pearson	475.242	445	.155
Deviance	399.747	445	.939

Link function: Logit.

7.5.8. Test of parallel lines

The statement was that the slope coefficients were approximately the same for all response cclasses. If the parallelism hypothesis is rejected, multinomial regression should be considered, which estimates separate coefficients for each category. However, the findings confirmed that there was no adequate proof to reject the assumption of parallelism. Consequently, the observed significance level was large ($p = .580$, greater than .05) (see Table 7.28).

Table 7.28: Test of parallel lines[a]

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	399.747			
General	363.140[b]	36.607[c]	39	.580

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value cannot be further increased after maximum number of step-halving.

c. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.

7.5.9. Pseudo R-Squared Measures

There are several pseudo R^2 measures, such as statistics that can be used to estimate the strong suit of the connection among the dependent variable and the prognosticator variables. They are not as valuable as the statistic in regression, since their clarification is not forthright. Usually, a set of three statistics are computed as a replacement for the coefficient of determination (R^2). Based on this standard, Nagelkerke/Cragg & Uhler's (1991) achieved the highest report (30.3%), then Cox & Snell's (1989) followed with 26.0%, and McFadden (1974) reported the smallest (15.5%). The best fitting model is the model with the largest statistics; therefore, in Table 7.29 Nagelkerke/Cragg & Uhler's (1991) (R^2) was the best, with 30.3%.

Table 7.29: Pseudo R-squared measures

Cox and Snell	.260
Nagelkerke	.303
McFadden	.155

Link function: Logit

7.5.10. Interpreting the Coefficients

From the observed significance levels in Table 7.30, e*xperiences in statistics, "computational self-concept", "effort"* and *postgraduate programmes* were all related to one threshold self-efficacy to learn statistics. In addition, *experiences in statistics* and "*effort"* had negative coefficients, while "*computational self-concept"* and *postgraduate programmes* had positive coefficients. Students with less experiences in statistics are less likely to reach higher score self-efficacy, and students who achieve less effort are less likely to reach higher score self-efficacy. Since its constant was positive, as postgraduate programmes increase, so does the possibility of being in one of the self-efficacy of account status. "*Computational self-concept"* has been a stimulus in statistics learning and most likely to reach higher scores self-efficacy, than those with lesser skill. Age does not appear to be related to the rating.

Definitely, age groups, gender, ethnic groups, type of study, department, none of the items regarding social support factors were significantly associated with the overall self-efficacy to learn statistics. However, the trivial effects of each category of these covariates and factors, aggregate and produce valuable evidence to the model.

Table 7.30: Parameter estimates

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[SelfEffAbsMeanOrd = 1]	.808	1.443	.313	1	.576	-2.021	3.637
	[SelfEffAbsMeanOrd = 2]	3.391	1.466	5.352	1	.021	.518	6.264
Location	Exp in Research Method.	.126	.217	.335	1	.563	-0.3	.551
	Exp. In statistics	-.539	.22	5.986	1	.014	-0.97	-.107
	Test of statistics	.302	.248	1.482	1	.224	-.184	.789
	Interpretation of statistics	-.312	.293	1.138	1	.286	-.886	.261
	Ask for Help	.179	.265	.457	1	.499	-.341	.699
	Worth of statistics	-.617	.402	2.362	1	.124	-1.404	.17
	Fear of stats monitors	.669	.327	4.202	1	.04	.029	1.31
	Comput. Self-concept	.015	.293	.003	1	.959	-.559	.59
	Affect	-.111	.246	.203	1	.652	-.593	.372
	Cognitive competence	-.33	.267	1.528	1	.216	-.853	.193
	Value	.085	.235	.131	1	.718	-.376	.546
	Difficulty	.005	.174	.001	1	.975	-.335	.346
	Interest	.245	.21	1.361	1	.243	-.166	.656
	Effort	-.465	.217	4.597	1	.032	-.891	-.04
	Significant others	.176	.229	.594	1	.441	-.272	.625
	Family members	.131	.241	.297	1	.586	-.341	.603
	Friends	-.262	.216	1.47	1	.225	-.686	.162
	Postgraduate prog.	1.148	.359	10.236	1	.001	.445	1.851
	Marital status	.573	.389	2.172	1	.141	-.189	1.335
	Agegp=1: 20-25	.62	.745	.691	1	.406	-.841	2.08
	Agegp=2: 26-30	.203	.625	.105	1	.746	-1.023	1.428
	Agegp=3: 31-40	.02	.565	.001	1	.972	-1.087	1.126
	Gender	-.078	.321	.059	1	.809	-.707	.552
	Ethnic gp: African	.181	.472	.147	1	.701	-.744	1.107
	Ethnic gp: Coloured	-.527	.522	1.02	1	.313	-1.55	.496
	Ethnic gp: India	.685	.682	1.008	1	.316	-.652	2.021
	Student status: S. Afric.	-.559	.566	.974	1	.324	-1.668	.551
	Student status: African	-.902	.548	2.709	1	.1	-1.975	.172
	Full-time	-1.158	1.751	.437	1	.509	-4.59	2.275
	Applied Sciences	.156	1.554	.01	1	.92	-2.89	3.203
	Business & Management	-3.162	1.784	3.143	1	.076	-6.658	.334
	Education	2.607	1.768	2.174	1	.14	-.858	6.073
	Engineering	1.115	1.323	.711	1	.399	-1.477	3.707
	Health & Wellness Sc.	.398	1.318	.091	1	.763	-2.185	2.981
	Art & Humanity	.424	1.333	.101	1	.75	-2.189	3.038
	Economy & Management	.213	1.366	.024	1	.876	-2.464	2.89
	Com & Health Science	.368	1.225	.09	1	.764	-2.034	2.77

		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
	[A9=11]	.109	1.256	.008	1	.931	-2.353	2.572
	[A9=12]	-17.413	0		1		-17.413	-17.413

Link function: Logit

7.5.11. Principle of Parsimony

In the complete models, the complementary log-log link was the best choice, because of its satisfying parallel lines assumption and larger model fitting statistics. However, the pseudo R-square measured the success of the model by explaining the variations in the data. The pseudo R-square was calculated depending on the likelihood ratio. For example, the McFadden's (1974) R-square compared the likelihood for the intercept only model, to the likelihood for the model with the explanatory variables, in order to assess the model goodness-of-fit. The interpretation of pseudo R-square in the Ordinal Regression Model was similar to that of the R-square (coefficient of the determination) in the Linear Regression Model. The pseudo R-square indicated that the proportion of variations in the outcome variable was accounted for by the explanatory variables. The larger the pseudo R-square was, the better the model fitting. The pseudo R-squares of McFadden (1974 [.371]), Cox and Snell (1989 [.600]), and Nagelkerke/Cragg & Uhler (1991 [.514]) in the complete model with the complementary log-log link, were larger than those of McFadden (1974 [.155]), Cox and Snell (1989 [.260]), and Nagelkerke/Cragg & Uhler (1991 [.303]) in the complete model with the logit link. Therefore, the investigation of the accuracy of the predicted response categories needs to be performed for the complete model with the complementary log-log (best model).

7.5.12. Examination of the accuracy of the classification results

In this section, how often the model can produce the correct predicted categories, based on the values of the predictor variables, is of most interest. A confusion matrix-by cross-tabulating the predicted categories with the actual categories was built. In Table 7.31, the model appears to be performing the function of predicting the outcome categories well; for categories-category 1 (a little confidence), the model correctly classifies 68.1%; for category 2 (a fair amount of confidence), it classifies 59.2%; and the category 3 (much confidence), it correctly classifies 27.6%. The best model demonstrated fairly high prediction accuracy (60%) for all three categories combined.

Table 7.31: Current responses against predicted response categories

Current response Categories		Predicted Response Categories			Total
		A little confidence	A fair amount of confidence	Much confidence	
A little confidence	n	79	29	8	116
	% within Current Response Category	68.1%	25.0%	6.9%	100.0%
A fair amount of confidence	n	34	58	6	98
	% within Current Response Category	34.7%	59.2%	6.1%	100.0%
Much confidence	n	1	20	8	29
	% within Current Response Category	3.4%	69.0%	27.6%	100.0%
Total	n	114	107	22	243
	% within Current Response Category	46.9%	44.0%	9.1%	100.0%

7.5.13. Correlation Estimated Classification Probability

Regarding the estimated classification probability for the best model, a Spearman's rho correlation coefficient was applied to explore the association between the predicted and actual category. Table 7.32 revealed a strong positive correlation between both variables; rho = .606, p < .000, n = 243. High levels of estimated classification-probability for a predicted category, is associated with high levels of estimated classification-probability for the actual category. The strength of the relationship represented 36.72%. The estimated classification probability for the predicted category may explain 36.72% in the variance of the estimated classification-probability for the actual category.

Table 7.32: Correlation between predicted and actual category

			Estimated Classification Probability for the Predicted Category	Estimated Classification Probability for the Actual Category
Spearman's rho	Estimated Classification Probability for the Predicted Category	Correlation Coefficient	1.000	.606**
		Sig. (2-tailed)		.000
		N	243	243
	Estimated Classification Probability for the Actual Category	Correlation Coefficient	.606**	1.000
		Sig. (2-tailed)	.000	
		N	243	243

**Correlation is significant at the 0.01 level (2-tailed).

7.6. Synthesis and partial conclusion

In this chapter, the results of the analyses of determinants predictors of SELS beliefs for combined data UCT and UWC were presented. The analyses were quantitative and based on three sections, namely, the univariate analysis; bivariate analysis, using a chi-square, an "independent-samples test" and a "One-way ANOVA"; and at multivariate level, with Ordinal Regression Models. The results of univariate analysis presented graphs, summarised tables with frequencies, percentages, means and standard deviations. The bivariate analysis comprised two sections, namely, the comparison of each variable across universities, and the comparison impact of each independent variable on SELS beliefs across universities. The results of the comparison of each variable across universities revealed that gender, age groups, ethnic groups, STASTATS, STARS, and effort were different across universities. In addition, the comparison of the impact independent variables on the SELS beliefs indicated that postgraduate programmes, SITSTATS, STASTATS, STARS, experiences in research methodology, support from significant others and support from friends were statistically significantly different in means SELS scores for the groups of these variables. Additionally, the multivariate analysis provided more statistically strong results, due to the consideration of control in the model. These models rely on the assumed probability distributions of the continuous variables (dependent) that underlie the observed ordinal variables. However, the Ordinal Regression Model, using complementary log-log link function for the combined data of UCT and UWC was the best model. The results of the Ordinal Regression Model, using complementary log-log link function, indicated that *experiences in statistics, ethnic groups, marital status, "effort"* and *postgraduate programmes* were significantly predictors of SELS beliefs. This result constitutes an important finding of this current study.

CHAPTER EIGHT

DISCUSSION OF THE FINDINGS

8.1. Introduction

In this chapter, the researcher focusses on the assessment of the knowledge development and learning approaches in statistics in the Western Cape, South Africa. The UNESCO, World Education Forum (2000) and White Paper 3 (RSA, NDoE, 1997b) recommendations around the effective learning of statistics that can improve higher education policy are specifically targeted. The ordinal regression model that provides a better understanding and interpretation of effectively applying statistical procedures was fundamental in this study. Therefore, the findings obtained from the analysis are discussed and interpreted in this chapter. The discussion covers three sections, following the research design. The first section focusses on an overall outline of the findings. The second section is focusses on the new facts implications, in terms of existing findings, and the meaning according to the context. In sum, the results are explained according to the context of the study, in the light of the literature. The last section presents the recommendations that could contribute to policy formulation.

This chapter commences with the assessment, at an individual level, of the prevalence and outcomes rates of different predictors (individual characteristics, experiences, STARS, SATS and social support) of SELS beliefs, followed by the influence of these predictors on the SELS. The ordinal regression model of SELS is also discussed, with respect to specific determinants of each university, as well as the combined data for both universities.

8.2. Main procedures followed in the research design

This research of the assessment of learning statistics, is both quantitative and qualitative, and is mainly built on causal comparison design, with the aim, not only to detect and explain the variations observed in statistics, but also to help improve new facts, or methods to adjust in the future. The application of UCT, UWC and combined data of both universities was executed to attain the goals of this study. Primary data obtained from the survey and the semi-structured interviews were used.

During the data collection operations, the approach of the enumeration in the surveys and the semi-structured interviews were face-to-face and self-completion. The survey was used to collect data relating to the individual characteristics, STARS, SATS, social support, SELS beliefs and past experiences. A pilot survey was conducted, to regulate the degree of validity and the reliability of the instruments, as well as ensure that the questions were clearly worded. Some items were refined according to the valuable comments of the respondents.

The collection of the information was captured through a single file of respondents. Data on self-efficacy to learn statistics (SELS) were analysed with the statistical programme, SPSS, by means of a built-in formula, structures, tables, and figures, which made it possible to conduct an overview constructed assessment on the quality of data. In each of the instruments used in data collection of the learning statistics and statistical procedures, different student *SELS beliefs* levels were obtained. Both ways were applied in the recording of *SELS beliefs*.

Descriptive statistics were used to display the *individual appearances, emotions, attitudes, social support*, as well as the *SELS beliefs* of the respondents. Dependability tests were lead to control whether the scales, adopted in the present study, were consistent. The evaluation of the differences in means for each predictor of *SELS beliefs*, made use of the "independent samples t-test" and a "One-way ANOVA" test. In addition, a comparison across universities of each variable, made use of chi-squared for the independence test. In some cases, all the methods were applied, and in others, only a few could be used, depending on the appropriate assumptions and the nature of the data at hand. The study applied an Ordinal Regression Model to structure a practical model of learning statistics for postgraduate students, and to have a better understanding of applying statistical procedures in research, effectively. The academic institution is taken into consideration in the analysis.

Regarding the qualitative findings, all the participants' comments were transcribed and coded, and presented in themes and sub-themes, according to the relevance of describing each category. Specifically, while examining the accuracy of the participants' codes, it was observed that, even among the participants with the same level of knowledge and standard, there were variations in what they understood a statistical test to be, and the sense of the usefulness of a statistical test. The three general themes that emerged from the analysis are displayed in Table 8.1.

Some contributing factors to this purpose included errors, confusion and frustration, arising from wrong procedures with respondents, difficulties in communication, lack of knowledge, misconception, misunderstanding, and misperception. Content errors were observed where characteristics such as the experience, postgraduate programmes, ethnic group, department and fear of statistics monitors of a respondent in the survey were incorrectly reported, or tabulated. In addition, content errors have diverse sources. For instance, a student records an incorrect response because of frustration or, a respondent provides a wrong response because of the lack of confidence and social appearance (over-estimation).

Table 8.1: Description of the qualitative data

THEMES	SUB-THEMES	CODES
Self-efficacy to choose a statistical test	Majors concerns about a choice of statistics test	Inspection of the data, outcomes
		Understanding of the concepts
		Understanding of problem
		Knowledge of assumptions
		Experiences In research
		Experiences in statistics
		Consultation of peer students
	Practical knowledge to choose a statistical test	Inspection of data, outcomes
		Interpretation of objectives
		Inspection of keywords
		Knowledge assumptions
		Experiences in statistics
		Checking different possibilities
	Confident about the decision made	Complete confident
		Much confident
		Confident/partially confident
		Easy understanding of the items
		Less time spent to choose
		Lack in statistics skills
		Conflicting choices
		Contradictions, doubt

THEMES	SUB-THEMES	CODES
Perceived failures to choose the right test	Causes of difficulty to choose the right test	Lack of Information
		Lack of knowledge
		Real life problem
		Non-familiarity with the items
		Misunderstanding of the items
		Confusion in interpretation
		Conflicting concepts in statistics
		Different area of expertise
	Reasons for rejection of some tests	Lack of information
		Misunderstanding of the concepts
		Assumptions do not allow
		Confusion, frustration
		Less evidence, difficulty to choose
		Referring to peer students
		Do not satisfy criteria for the test
Non-familiar statistical tests	Not familiar items	Discriminant analysis
		Effect size
		Factorial ANOVA
		Fischer Z transformation
		Friedman two-way ANOVA
		Kruskal-Wallis for One-way ANOVA
		Partial Correlation
		Path analysis
		Post-hoc comparisons of means
		Sandler's A statistics
		Semi-partial correlation
		Sign test

8.3. Discussion of the findings of each academic institution

8.3.1. Assessment of the findings at UCT

Regarding UCT's findings, the evaluation is based on the quantitative and qualitative results.

8.3.1.1. Assessment of the quantitative findings at UCT

The assessment of the quantitative results is elaborated under three sub-headings, namely, the descriptive analysis, the impact of the predictors of SELS beliefs, and the evaluation of the multivariate analysis. For the UCT, the evaluation of the impact of the predictors of *self-efficacy to learn statistics beliefs (SELS beliefs)* attempted to respond the subsequent study questions: What are the effects of the individual characteristics, emotion, behaviour and social support on the SELS beliefs at the UCT? In this current study, the researcher aimed to investigate the associations of *SELS beliefs, background and academic variables, prior experiences, statistical anxiety, attitudes towards statistics* and *social support*. The scores from the various instruments identifying the *experiences in research methodology, experiences gained in statistics, STASTATS, STARS* and *effort,* were in a statistically significant association with *SELS beliefs*.

More than 60% of the postgraduate students scored the highest category in *experiences in research methodology*. *Experiences in research methodology* presented a statistically important means change in the groups, with a moderate effect size, $F(2, 148) = 4.769$, $p = .010$. There was a positive association between *SELS beliefs* and *experiences in research methodology* of the graduate students. The positive association is coherent with Onwuegbuzie's (2000a) conclusions. The respondents achieved the highest scores in the *experiences in research methodology* subscales, indicating the graduate students' enthusiasm and fervour for a positive confidence in the implementation and resolution of statistics. General, these outcomes, as well as the positive association between *SELS beliefs* and *experiences in research methodology,* seemed to describe a kind of self-assurance expectation that postgraduate students undertake, when compelling statistics. Postgraduate students, who may experience under stress to seem publicly wanted, may under-record their levels of statistics anxiety, as well as over-record their levels of performance, which is similar to Williams' (2014) findings.

Regarding *experiences gained in statistics*, 43.7% achieved the *Good* level. However, only a miniscule percentage (.7%) of the postgraduate students scored

Very bad in *experiences gained in statistics*. Those who scored *Average* in *experiences gained in statistics* were 39.7%. The means score achieved in *experience gained in statistics* was good (3.6), F (2, 148) = 3.478, p = .033. *Experiences gained in statistics* revealed a statistically substantial means variance in the categories with small effect size. A positive association was established between *SELS beliefs* and *experiences gained in statistics*. These outcomes designated that, when the graduate students' *experiences gained in statistics* increased, their *SELS beliefs* were higher. The results indicated a better response to *experiences gained in statistics*, not generated in other researches, where students were presenting with undesirable experiences in statistics (Gal & Ginsburg, 1994). Remarkably, the postgraduate students in this current research were average in their ability to learn statistics, lacking great feedbacks.

The majority of the respondents indicated a low anxiety in *STASTATS* (statements related to statistics). In addition, the findings of an "independent samples t-test" exposed that the mean difference = .887, t (149) = 3.202, p = .002, two-tailed. There was a statistically significant negative association between the *SELS beliefs* and *STASTATS* of the postgraduate students, with moderate effect size (eta squared = .06). The negative association is coherent with Onwuegbuzie's (2000a) outcomes. The respondents achieved their lowest responses in the *STASTATS*, revealing the postgraduate students' willingness to *asking for help from the supervisors and monitors*, their slight belief in the solving of real world problems, as well as the purpose of statistics. Beurze *et al.* (2013) claim that possessing a good background in statistics does not ensure good performance. Generally, these results, as well as the negative association between *SELS beliefs* and *STASTATS anxiety* created the impression of a self-prediction that postgraduate students adopt, when taking statistics. However, the actual findings were not consistent, and completely different to the Mji (2009) report, where more than half of the respondents obtained high anxiety. Therefore, the lower *STASTATS anxiety* of the postgraduate students towards statistics is associated with higher *SELS beliefs*.

Similarly, the respondents reported a low level of *STARS anxiety* (overall statistical anxiety), which indicated that most of the postgraduate students believed that they were not anxious, and had a better knowledge of statistics.

Additionally, a statistically significant association was established between *SELS beliefs* and *STARS anxiety*, with a moderate effect size (eta squared = .08), mean difference = .828, t (149) = 3.615, p = .000, two tailed. The respondents perceived *STARS anxiety* as a leading issue in their existence, which is comparable to Beurze *et al.* (2013) report, where second year students, who scored higher on the statistics, revealed lower anxiety on the STARS scale. Poor communications between the instructors and the students might be one of the reasons for statistics anxiety. Students are encouraged to relay their most important questions to statistics monitors, or peers. However, *STARS anxiety* was a statistically important interpreter of *SELS beliefs*.

Regarding the SATS, a shortcoming must be highlighted about the general attitude assessment. Only *effort* indicated a statistically noteworthy means modification in the sets, with a large effect size. Though, it was observed that, about, 70.9% of the respondents showed a high positive SATS, which is alike to previous results (Chiesi & Primi, 2009; Perepiczka *et al.*, 2011). *Effort* revealed the prominence of the postgraduate students' determination in their capability of resolving the defies of learning statistics. Therefore, F (2, 148) = 10.936, p = .000. Also the clear constraint for supervisors to guide the statistics subject, it may be vital to discuss the importance of statistics, how it is relevant to the research, as well as its expectations in graduate programmes. The *experiences gained in statistics* and *exposure to empowerment (effort)*, as well as *type of study* are not favoured by postgraduate students from the Art & Humanity, as well as Law departments. Apparently, students from these departments mostly achieved lower levels of confidence in *SELS beliefs*, compared to those from other departments. In a poor context, such as the Law department, where more than 98% of the students achieved under the bottom line in *SELS beliefs*, with a little confidence, the influence of the effort status is quite evident. The results of the multivariate analysis revealed that students with bad experiences in statistics have 5 times more apprehension of *SELS beliefs*, than those, who performed well. In fact, bad scores indicate a lack of confidence, which, therefore, is challenging during or after graduate programmes. The professors, or statistics monitors could enact a main character in influencing their students' SATS, positively. Inserting humour, showing compassion, supplying a confident environment for students to exchange about their tests, and rejoicing their minor achievements, are be tools that could be employed to combat negative attitudes.

However, there was no change in the association between *academic, demographic* and *SELS beliefs*; therefore, each of them was not a contributing variable. Similarly, *SATS* and *social support* factors were not statistically significant in means difference among the groups. SELS beliefs scores from the respondents designated moderate responses, which reflected previous experiences, connecting undergraduate students (Pajares, 1996; Zimmerman, 2000). As this current study was the first in this context to investigate postgraduate students, these outcomes making a track for upcoming study.

Multivariate analysis: What are the factors that significantly predict student's SELS beliefs at the UCT?

The evaluation of the results of ordinal regression to build a model with the UCT data, using Logit link function, revealed that the "*fear of statistics" monitors, postgraduate programmes, engineering department* and *health & wellness department* were the significant determinants of *SELS beliefs*, among the predictors selected for the analyses. In fact, the multivariate analysis of the UCT data indicated a positive effect of the *postgraduate programmes, engineering department* and *health & wellness department* on *SELS beliefs*. In addition, the *postgraduate programmes* affected the traditional beliefs and the daily practices of student learning in diverse social and economic ways. The postgraduate programmes' practices and norms could determine the student's educational and learning style exposure to a certain degree, the attraction to a specific department or another, practices regarding support, choices of consultation for assistance, such as asking for help (supervisors or peers). However, the influence of the postgraduate programmes also depended on the type of study, test factor and interpretation factor. In sum, these results proved that masters' students from *Engineering* or *Health & Wellness* were more responsive to *SELS beliefs*, than the other abovementioned, because of some practices regarding their experiences in statistics, marital status, type of study, their empowerment and supports.

The univariate analysis performed on UCT's data revealed that 62.8% of the postgraduate students were in master's programmes, while 37.2% represented those in PhD/post-doctorate programmes. Despite the number of students engaged in postgraduate programmes, there was no major modification in the means scores of *SELS beliefs*, regarding *postgraduate programmes*.

However, the findings from multivariate analysis revealed that *postgraduate programmes* were a contributing factor in the model (RC = 2.001, p = .003). Master's students were encouraged to engage in postgraduate programmes. These studies are very important for the detection of possible problems. Statistics are important in graduate programmes, and UCT has made efforts (tutoring, assistance by peers), at the department level, to improve their students' knowledge. In cases of difficulty, this action will assist students to overcome their relevant challenges.

The results revealed that when *emotion* ("fear of statistics monitors") increases, the possibility of *SELS beliefs* decreases. In addition, the results revealed that "*fear of statistics"* monitors was a statistically important prognosticator of *SELS beliefs*. This was a key result that emerged from the stepwise Ordinal Regression Model. In brief, "*fear of statistics"* monitors only decreased the chances of *SELS beliefs* among graduate students at UCT. The univariate analysis highlighted that 83.4% of the postgraduate students presented with low anxiety for the "*fear of statistics"* monitors, compared to 4% with high anxiety, while 12.6% presented with moderate anxiety. Though, a major mean variance was observed between the "*fear of statistics" monitors* groups. The findings of the multivariate analysis confirmed that it significantly contributed to the prediction of *SELS beliefs* (RC = -1.109, p = .045). Obviously, students with less anxiety probably maintained higher confidence levels in *SELS beliefs*.

The findings about poor communications between students and statistics monitors seemed to concur with a previous study, conducted by Ruggeri *et* *al.* (2008), with two universities in Northern Ireland, where undergraduate students appreciated their awareness of statistics. Easy communications between supervisors and students could be a possible reason. Among others, the STARS questionnaire is self-reported, and some postgraduate students, who may be under stress to seem publicly wanted, may tend to overestimate their emotion.

All the instruments applied in this research allowed for self-reporting and, consequently, exposed to subjective preference. This disproportionate representation of students' emotion revealed a need for intervention, to improve their attitude, and overcome their fear of statistics. Similarly, the findings of Pan and Tang (2004), regarding the application of the statistical perceptions to enlighten real-life difficulties, provided graduate students with occasions to strengthen their knowledge.

The respondents showed that *fear of failure* was one of the sources of anxiety. In addition, the "*fear of statistics"* monitors', revealed that the contributing factors might be varied, from math phobia, misunderstanding belief around statistics, to the instructors' attitude about the absence of linking to tangible difficulties. If the instructors were more sensitive to the students' challenges, it would be likely to assist postgraduate students in academia to study statistics more efficiently. Addressing their anxiety and supplying handling approaches to the students, were suggested in the literature (Pan & Tang, 2004; Wilson, 1998), as active practices for the reduction of STARS.

The findings of the univariate and multivariate analyses of UCT's data, using the Logit function, highlighted the Engineering and Health & Wellness departments as important significant factors of *SELS beliefs*. In fact, both analyses proved that these departments were more capable of *SELS beliefs*, than any other department was. Indeed, students from the Engineering department were, at least, 30% more proficient at *SELS beliefs*, than those students were in the Art & Humanity, as well as Law departments. The risk of not possessing SELS beliefs reduces with the engineering department. A lower risk was observed among Engineering students (Regression coefficient = 7.364, p = .001), followed by students from Health & Wellness (RC = 3.612, p = .035). The research findings concerning Sciences departments in this study appeared to be similar to a preceding study conducted by the South-Western University in the USA (Williams, 2014), where graduate students strongly valued their learning environment. This current study's results could be important for policy makers and planners, because the youth (students), considered as the future of a country, are the most vulnerable regarding learning statistics. It may be important for students to know why statistics must be knowledgeable, in what way it is appropriate to the chosen major of graduates, and what potentials in graduate schools may be.

More engineering students had an improved appreciation of the significance of statistics for their prospective professions. Centred on the reactions, this maybe connected to the illustrations done in the class. For instance, students in Health & Wellness may use medication sales data to demonstrate a point, or possibly carry out investigations, and suggest explanations. Psychology, as an example, may provide a dissimilar method. The bulk of Psychology majors are naturally concerned in direct services, which are often in the areas of clinical or counselling psychology. Most of the Psychology lecturers, who explain statistics, are probably from non-clinical experiences. It may be that the cases applied by these lecturers could be related to their area of interest, than the benefit of the students.

The Law students may follow vocations that are more service oriented. As such, they may observe their forthcoming service in areas of audition, parole, prisons, juvenile justice, and others, as fields that will not require them to be great consumers of statistics. One method might be to decide the imminent vocation ideas of students and supply cases that would be fitting in those conditions. Nonetheless of how this is to be applied, lecturers of Psychology and Criminal law surely have much progress to make, in order to supply students with more evidence on how statistics will be pertinent to their coming works.

However, similar results were found with some researchers, who had inspected attitudes toward statistics within one discipline, and have recommended appraisal across majors (Coetzee & van der Merwe, 2010). Mij (2009) scrutinised the variances in a business school. Evaluations were conducted among undergraduate students from Accounting, Taxation, and Marketing. It was found that Taxation majors had more undesirable attitudes toward statistics, than the other two groups. Because of the prominence of statistics, as a compulsory course through diverse disciplines, as well as the limited amount of research comparing different majors, such contrasts may produce exciting outcomes, and expose diverse patterns through many disciplines, which could be used to improve statistics courses, for students of a given major.

The statistics monitors can play a significant role in positively influencing their students' attitude toward the subject. Adding humour, demonstrating empathy, developing a safe space for students to talk about their tests, and initiating small success celebrations of students can enhance positive attitudes.

On occasion, the consultations with the students do not reveal any problems, and the students discontinue the assistance (supervisors or peers). In addition, occasionally they do not have the means to continue the academic programme, or maybe they do not have necessary financial means to access all the facilities; therefore, they seek more cost-effective alternatives outside the academic system. This is generally more commonly found among poorer students, and those from rural areas; however, it could also occur among students from urban areas (Eccles & Roeser, 2011). In fact, some beliefs related to customs or traditions are the reasons why some women abandon educational programmes, because of misperception or mystification. However, it is also evident in literature that many students from disadvantaged areas, or females, are not able to deal with mathematics issues; therefore, they tend to give up easily when complications arise, or after the failure in task execution (Hill *et al.*, 2010; Ong *et al.*, 2011).

In a context where the entire population is dominated by youth, with a minority of elders, the urgency of the issue becomes patently clear. Helping graduate students to choose a positive view to explore essentially negative attitudes, and to appreciate the usefulness of statistics in their profession, may be good starting points for developing salient attitudes towards the statistics.

8.3.1.2. Assessment of the qualitative findings at UCT

Theme 1: Self-efficacy to choose a statistical test

The data were exposed to thematic analysis. One of the most difficult (and potentially fear-inducing) elements of the research procedure for most students is selecting the precise statistical technique to examine the data. The determination of choosing a relevant test for statistical analysis be subject to the nature of the variables, sample size, procedure and assumptions. In addition, a postgraduate student has to be assertive regarding all information of the interview, as well as interested to be involved in the study.

The participants recognised that they were aware of their choice of statistical tests, which helped to assess their level of ability and eventually highlighted or revealed the conditions related to the difficulty of making a wise choice. Despite previous experiences in research methodology and statistics, some participants realised that the choice of the tests remained challenging; therefore, there was limited availability of information in those scenarios. *Major concerns about a choice of a correct statistics test*, *practical knowledge to choose a test*, and *confidence about the decision made*, were three sub-themes that resulted from the main theme. In addition, interaction among the participants enhanced the data quality.

- ***Major concerns about a choice of a statistics test***

  The responses, generally, were related to inspection of the data, understanding of the concepts, knowledge of assumptions, experiences in research methodology, experiences in statistics and consultation with peers. The greatest shared reactions concerned data problems, such as, understanding of the concepts, frequently due to the amount of time since the preceding mathematics or statistics class, and grades. The results indicated that the participants were challenged to choose the correct statistics test, as their inspection of the methodology and the sample size limited their flexibility. This could be an anxiety, which relates to worth of statistics, or fear to ask for help, during the learning process. Geary *et al.* (2008) recommend that extremely anxious students frequently have fairly poor self-assurance, misjudging the quality of their self-efficacy beliefs, when associated with others. Therefore, it appears that the students have become aware of, not only the mistakes they made, but also how to resolve it against future occurrence. This is a clear indication that assistance dynamics such as these, help students to develop better learning strategies. The findings seemed to agree with Laurillard (2013), who claims that the external activities of the learning environment tend to influence the internal cognitions of students. It appears that in some situations, learning is influenced by the comprehension needs of the students (Schmeck, 2013). This experience was shared by participants 3, 4 and 5, who said that they experienced difficulties in performing choice procedures. The following quotations refer:

> "*Humm, in general that it is in general you can say as what it is asking for like the measurement, the measures, then also the guide of methods that was supposed in that particular study, and then also the sample size for sampling frame so those are straight things that I am looking at to decide which one to choose.*" ***Participant 3***

> "*I looked at the method that it is appropriate so applied to the problem at time.*" ***Participant 4***

> "*So, I look at the type of the question that you are trying to ask, and if you are looking or if you are trying to investigate the effect size, then looking for something regression you are trying to test like the relationship between two things that it is*

probably a t-test or something that's sort of like a guideline for that." ***Participant 5***

The research findings in this study appeared to be identical to a previous study conducted by Hembree (1988), who asserts that, in academic achievement, lesser levels of self-efficacy are related to advanced test anxiety, as well as greater disparities in task understanding. This is another instance where the interaction in learning environments becomes a process that prompts students to reallocate not only cognitive gains and effort, during the learning discourse, but also to critically examine possible sources of errors. This process is used individually and cooperatively. Studies have revealed that peer-interactions, during the monitors learning process, are critically important (Laurillard, 2013). In this sense, participants 9, 10, 1 and 7 acknowledged that the inspection of the data and the previous experiences helped them to achieve the relevant choice, as the following quotations reveal:

> *"First with the available data, I have made different comparisons, qualitative data and quantitative data, I deal with one group or two groups, then the group of dependent and the group of independent, the data related like in which … different of means …"* ***Participant 9***

> *"I choose to answer the tests based on the knowledge first that I have about statistics and which relevant topics that applied to certain, humm certain description of data or information that I have to deal with."* ***Participant 10***

> *"Humm, based on my first year Stats course, three semesters of stats, so I know something about stats, but I'm like, about four years ago, and, and then any other experience I've had, was straight the research."* ***Participant 1***

> *"Ok I just tried to remember some of the things that I previously on courses I took in statistics and then some work that I have done on my research, previous research based on what I have*

done in the past, that's what influence my decision." ***Participant 7***

Having the knowledge of assumptions, enables graduate students to choose the correct statistics test, relevant to the scenarios. In this sense, the findings revealed that the respondents 8 and 2 insisted that the knowledge on assumptions was essential in statistical procedures, and constitutes a great challenge that could even lead someone to consult statistics monitors or peers. The following quotations refer:

"*Yes, the first thing is no matter what I will do is to look at the analysing principles, the questions that you want to answer, and then you look at the tiers that would allow you to answer such the questions. So that is what I use to analyse what I choose the answers that I choose for the various scenarios but I didn't have enough time to sub-check each scenario or proper structure also of these could not be exactly what I will be doing right in the real science you know if I have time enough, you know, yeah.*" ***Participant 8***

"*Humm, it depends on the parameters that I would have there are two groups I just know that if one is dependent or not I will know the test.*" ***Participant 2***

The participants were concerned about their experiences in research and statistics, and were frustrated with their efforts to understand the case studies, in order to apply them more effectively. They expressed the need to learn how to apply their experiences consistently. These findings were in accordance with the findings of previous studies. For example, a study conducted by Field (2009) suggests that, the failure in learning statistics is due to undesirable practices in preceding statistics classes. This experience makes students fearful of statistical concepts; therefore, they believe that they do not have sufficient mathematics exercise to do well in statistics. The following quotations refer:

"*Humm, based on my first year Stats course, three semesters of stats, so I know something about stats, but I'm like, about four years ago, and, and then any other experience I've had, was straight the research." **Participant 1***

"*Ok I just tried to remember some of the things that I did previously on courses I took in statistics and then some work that I have done on my research, previous research based on what I have done in the past, that's what influence my decision.*" ***Participant 7***

"*I choose to answer the tests based on the knowledge first that I have about statistics and which relevant topics that applied to certain, humm certain description of data or information that I have to deal with.*" ***Participant 10***

The participants argued that the time required to complete all the items was limited, making it difficult for individual work and energy to be deployed. However, by working alone, they were more involved in all aspects of their choices, as the following quotations indicate:

"*Thank you for taking my time." **Participant 8***

"*Realistically telling I will put myself as C because I didn't have time to really subject each scenario" **Participant 8***

"*Because the question asked, you need to understand them first then; you need time to identify what test to be applied to the problem you can't just say require this method for this problem.*" ***Participant 4***

- ***Practical knowledge to choose a statistical test***

  Students are likely to apply more time seeing basic problems, with the hope that possible responses and explanations will arise progressively, lengthways with the conceptualisation of the problem itself (Schmeck, 2013). Unfortunately, educational researchers focus on the participants' perceptions and conceptualisations of situations experienced. In so doing, awareness includes a performance of organisation, in which a condition is harmonised to patterns that changed from lived practices, for example, an assessment condition, or assertiveness condition. For selected students, the original situation comprises, potentials of disappointment and disgrace, calling for self-efficacy, compliant approaches that lead to accurate recurrence of the declaration of authors, parents, peers or statistics monitors. Such boring strategies produce only a fragmentation of understanding. In other students, the proto-typical pattern to which the condition is harmonised comprises potentials for stimulating and original creativity, calling for a mixture or addition of all reasoning meanings.

In line with Schmeck (2013), the findings revealed that the participants experienced the practical knowledge to choose a statistical test, as a series of difficulties that they had to resolve. These difficulties consist of the review of data and concepts, interpretation of objectives, identification of expected outcomes, description of assumptions, application of previous experiences in statistics, examination of different options, and choosing the appropriate statistical test. Each item was experienced as stressful.

Regarding the inspection of data and results, it was experienced as challenging, frustrating and intimidating. The participants became unsatisfied and disappointed. This conclusion was consistent with the theoretical framework, as stated by Pintrich (2004), that students, who had experienced all these characteristics, were expected to adjust certain strategies during their learning process, such as learning from failures. Unfortunately, the failure of students to address the difficulty of selecting the correct approaches, tended to be recurrent in statistical learning, as the following quotation express:

> **"***Yes, there is a certain information that talked about the distribution, certain information that talk about variances, certain information talk about frequencies and then you know you can actually deal with frequency or you can largely give the distribution of variance so it depends on which term that*

actually you found or something that, as some data that give you an idea that actually they are looking for frequencies then you can actually …” ***Participant 10***

How a student tackles the assignment of interpretation a theoretical situation. The student starts with the goal to excerpt individual sense from the item, which directs to a lively method of knowledge, in which the student tests the concepts, confirmations, and influences presented by the authors, attempts to appreciate correlations among the concepts offered, seeking relations with individual knowledge and the outside world. This in turn, implies that the student is rebuilding information within a personal background. Fullan (2007) describes that the action is proposed to establish a system of expressive networks among the original evidence and earlier well-known ideas, thoughts, and accurate evidence.

Authenticity is achieved by drawing connections to the real-world, to students' everyday life and to practice in the discipline, as well as requiring transformation of knowledge. Content is often situated in questions, problems, designs or attaching events that encompass important subject matter concepts, so that students learn ideas process and skills as they go about working. These meaningful problems create a need to know a situation, to learn specific ideas and concepts, and provide a reason to understand. They provide students with multiple opportunities to work with concepts around the driving questions, and the real-world problems under-study. The following extract from the collected data refer:

“*I just choose so if I read the questions and then I found that maybe two tests will be fitted so, I just choose the more relevant one according to me yeah, so I just reject the other one and pick the most relevant.*” ***Participant 9***

Regarding the interpretation of objectives and assumptions, the participants were annoyed when they considered that they did not expect a satisfactory result in their choice. These results were in accordance with the findings of Black (2012), who evaluates the effectiveness of statistics reasoning and assessment. Black (2012) declares that, when students are faced with uncomfortable and incorrect data, they do not think beyond the content, since different interpretations are based on different assumptions. Students are deceived because their experiences are based on uncertain intuitions, errors and misconceptions. The following quotations refer:

"*Basically say, is that aligned principles, what questions are you asking, what data do you have, what question do you want to answer with the data you have?*" ***Participant 8***

"*So, I think the outcome measures may cope the statistics I hope the statistics yah, the one that actually let me decided which one to cope for.*" ***Participant 3***

Students are more concerned with assignment achievement than with refining their knowledge and abilities. Therefore, during the mechanical process of repetition memorisation, students may well be unsuccessful to differentiate among vital opinions and secondary evidences, or between standards and illustrations. They are doubtful to link indication and assumptions, or inspect the argument in a serious method. In fact, the participants realised that the application of previous experiences in statistical procedures should not be a stress-free task and could be confusing. Despite the fact that the assumption guidelines allowed them to move forward in a rigid way, they had to consider multiple decisions simultaneously, to appreciate the differences and similarities. In this sense, Schunk and Pajares (2010) argue that postgraduate students from different cultural backgrounds have a different understanding. Learning statistics requires that students should approach new ideas and concepts critically. Some of them interpreted these approaches as different from their previous experiences, as the following extract indicates:

"*Humm, based on the description with each question, humm, I sort of worked out on how many variables there were and then any table was given, humm, I tried to relate that back to something that I had seen before, based on the Stats course I did. So, for example if there was just a simple two independent* *groups to test, I would use a t-test. So that's what I would, that's how I would answer the question.*" ***Participant 1***

The development of knowledge, therefore, could be understood as progressive, in that it be unsuccessful to comprise the critical phase of reorganisation and reclarification, and the conclusion is a, more or less, broad imitation of the scenario, which is doubtful to comprehend the central core of the writer's information. The innovative construction of the method to the learning idea had a fine attention. Even in this fine attention, there is strong indication that the method accepted by the student is adjustable overtime and above situation, and in this inconsistency the effects of incentive on method develop strong. After the experience, a processing phase of reflection occurs. Reflection is an important human activity, in which students recapture their experience, think about it, consider it over and evaluate it (Boud, Keogh & Walker, 2013). It is only when students bring their ideas to their consciousness that they can evaluate and begin to make choices about what they will, or will not do.

According to Becker (2008), students believe that choosing a statistical test is something they randomly select; however, further ahead they realise that there were more choices than they had assumed. Therefore, they become concerned and afraid of making mistakes. The following quotation refers:

"*Ok I just tried to remember some of the things that I did previously on courses I took in statistics and then some work that I have done on my research, previous research based on what I have done in the past, that's what influence my decision.*" ***Participant 7***

- ***Confidence about the decision made***

Biggs (2011) examines the opposing stages of essential and extrinsic incentive and its effects on students' methods to interpretation an theoretical task. He determined that students, who had originate the item motivating, or pertinent, were more possible than others to accept a profound method. In difference, students who had originate the trial demanding, demonstrating extrinsic incentive because of nervousness, inclined to accept superficial methods. For postgraduate students, most events that precipitate reflection emerge from normal occurrences in an individual's life. The motivation may arise from a loss of confidence in, or disillusionment with, an existing situation.

This current study's findings are in line with Biggs' (2011) claims that learning approaches are more passive for students at the beginning, and should be implemented in their lives, by repeating it until they are confident enough. The following quotations refer:

> "*Humm, in general, I'm very confident, pretty confident. Yes, (laugh).*" ***Participant 1***
>
> "*Yeah, so in which test? I'm above 80% confident.*" ***Participant 4***
>
> "*I would say like 80% confident.*" ***Participant 2***

In subsequent research into students' every day learning, the effects on method of attention, in terms of valuation stresses, have been established (Entwistle & Ramsden, 2015). Students described how the eagerness and understanding of the statistics monitors affected their methods to learning (Entwistle & Ramsden, 2015). In all these conducts, the method to learning statistics has been originate to be flexible, liable on both the tenor, as well as the framework of knowledge. This could be provoked by an external event, or could develop from an individual's own likeness on a whole series of incidences over time, causing a dissatisfaction that leads to a reassessment of them. The following quotations refer:

> "*Some of them because humm, maybe some of them are not exactly like the options are noted exactly phrase the way like I know them, you know, maybe I know like two samples paired t-test like that but also in there, they are also make phrase different maybe for me there are also the same.*" ***Participant 3***

"*Because not sure, I could not just put anything there that I have, I want to put something when I am sure.*" ***Participant 10***

"*I just choose so if I read the questions and then I found that maybe two tests will be fitted so, I just choose the more relevant one according to me yeah, so I just reject the other one and pick the most relevant.*" ***Participant 9***

Although some students were reliable, most could be confidential as accepting either a profound or a superficial method to a mainstream of the tasks, although the perceptions of the participants improved as the tasks progressed. When the participants made their own decisions, they viewed this as a personal revelation of their strengths, as well as progress of their abilities. Similarly, while examining the students' ability, this current study confirmed the results obtained by Fullan (2007), who claims that students tend to interpret new information according to the knowledge they already have, to construct their own meaning, by linking the new idea to what they already understood. The following quotations refer:

"Humm, in general, I'm very confident, pretty confident. Yes, (laugh)." ***Participant 1***

"I'm above 80% confident." ***Participant 4***

"So, the only think is you have to read the question that have been asked and try to relay them back so which is I mean need time, the time is the major problem. Because the question asked there you need to understand them first and relay them to the test that are used even you are familiar with the test, you need time to identify what test can be applied to the problem you can't just say require with this method and this problem is then I can use any method." ***Participant 4***

Inappropriately, some of the students encountered conflict, doubt and reluctance in their choices. Support from peer students and from statistics monitors was required. These findings to concur with those of a previous studies conducted by Andersson *et al.* (2006) and Reed (2010), in which the collaborative mentor-apprentice model that is applied for post-graduate instruction is largely consistent with the literature documenting. Therefore, the supervisor still holds a special place, acquired by training, maturity and knowledge. The following quotations refer:

> *"Mann-Whitney U- test, Sandler's A statistics, path analysis, Fischer z transformation, I'm not sure, yeah, and Semi-partial correlation, Pearson's product –moment correlation, that I have haven't never seen before. Then the others, I have some ideas, yeah."* ***Participant 9***

Despite the fact that participant 2 completed the interview, he was still not confident enough about the selection and expressed his desire to learn how to apply connections between statistical procedures and the real world problems, as indicated in the following extract:

> *"I would like to be thought you see what I mean so I know you could show me how to then observe the ways like I make up you see the data and then you decide which analysis they are declined. Because I have been following up I have done the training on literature, training on like English in terms of literature but such thing I have never seen any statistics course."* ***Participant 2***

> *"Can you make time to teach if you have to …?"* ***Participant 2***

8.3.2. Assessment of the findings at UWC

8.3.2.1. Assessment of the quantitative findings at UWC

The evaluation of the quantitative findings is sectioned in three rubrics, namely, the descriptive analysis, the impact of the predictors of SELS beliefs and the evaluation of multivariate analysis.

This section attempts to address the subsequent study question: **What are the effects of the individual characteristics, STARS, SATS and social support factors on the students' SELS beliefs at the UWC?** The purpose of this question was to explore the means difference of the SELS beliefs among groups. The importance of this knowledge helped to investigate the association between SELS beliefs (self-efficacy to learn statistics beliefs) and possible predictors.

Regarding *postgraduate programmes*, the descriptive analysis indicated that 60.3% of masters' and 39.7% PhD/post-doctorate students were involved in this current study. In addition, an "independent-samples t-test" exposed a statistically substantial change in the means score of SELS beliefs between masters and PhD/post-doctorate students at 95%, with M = .626, t(154) = 4.152, p = .000. The researcher assumes that maybe PhD/post-doctorate students still need to be encouraged about the importance of statistics in their research, or future career. This assumption might explain why PhD/post-doctorate students did not have a good understanding for the purpose of statistics, or possibly, they considered it difficult to apply statistics to real problems, based on their previous experiences. As for the masters' students, they were excited to attempt an academic research. Involving the students with their own investigation, through their programme of education, would possibly assist to promote statistics understanding.

The findings revealed that the marital status of the graduate students could improve their level of SELS beliefs. According to the findings, single students (64.5%) predominantly exhibited less probability of expanding their SELS beliefs, compared to their married counterpart (35.5%). These findings highlight the need for more married graduate students, with a keen disposition towards SELS beliefs. Additionally, these findings highlight the need to educate married graduate students in issues related to the ability to learn statistics. In fact, being single should contribute to the learning strategies of graduate students, and the ability to make the right choices regarding workshops, or seminars. The perception is that single graduate students are reliable, have fewer responsibilities, and are available to attend any programmes (consultations with peers or supervisors, seminars and workshops) with less complication. Whereas, married students have diverse responsibilities, and might not be able to follow their timeline schedule easily, because they need to earn extra revenue to sustain their families.

Regarding SITSTATS, the univariate analysis revealed that 50% of the graduate students achieved a low anxiety level, against 9%, who achieved a high anxiety level. The results of an independent-samples test acknowledged the difference observed in the means scores, which was statistically significant, indicating that students with low anxiety in SITSTATS are associated with high SELS beliefs scores. The maturity of these graduate students in statistics application could be one of the main reasons for the self-control of their emotions. SITSTATS represents a total score of "*worth of statistics*", "*interpretation of statistics*", and "*test and class*" anxiety. Bell's (2003), whose study at a USA university observed similar results, acknowledges that traditional postgraduate students may experience a low level of anxiety, compared to non-traditional postgraduate students, simply because they are using the same learning strategies, or method of study, and may be aware of a certain number of strategies.

The STASTATS results were assessed, and although the descriptive findings revealed that 71.8% of the respondents achieved a low anxiety level, compared to 7.7%, who achieved a high anxiety level, an "independent-samples t-test" determined that there was an association between STASTATS and SELS beliefs. Therefore, students with low SELS scores are linked to high anxiety scores in STASTATS. Given that totally of the instruments applied in this research were self-reporting, and so, subject to subjective preference, postgraduate students, who may experience under stress to seem generally necessary, may under-estimate their levels of statistics anxiety, and over-estimate their levels of SELS beliefs. STASTATS describes a total score of "*computational self-concept",* *"fear of asking for help"* and "*fear of statistics"* monitors. This finding is in accordance with the literature. For example, Williams (2014) argue that new investigations, to reveal ways through which social status could influence the attitudes of graduate students, are reducing bias, although this impacts negatively on their SELS beliefs. Therefore, the number of times without biases supports the finding that STASTATS is significantly associated with SELS beliefs.

Another interesting finding from the univariate analysis, depicted in Tables 6.10a and 6.10b, are that *STARS* remains a contributing factor to the reduction of the *SELS beliefs*; however, in this current study's further analysis, the results reveal that it is, instead, a stimulant of improvement of *SELS beliefs* scores. The findings in Chapter 6 indicate that only 5.1% of the respondents achieved a high anxiety score in *STARS*, compared to 63.5% with a low anxiety score. However, a statistically noteworthy modification was found among the mean ratings for students' low and high anxiety in *STARS beliefs*. The prevalence of STARS is not only due to the absence of practical skills, or to inadequate abilities, but similarly to external factors, or previous negative experiences. This finding concurs with the theoretical framework postulated by Hutchinson *et al.* (2008) that the mean differences in statistics anxiety, across different groups, could be perceived as a measurement of items, instead of real differences in the perception of statistics anxiety, without a measurement equivalent. The assumption of equivalent groups is incorrect. The absence of measurement equivalence implies that sub-group responses are not meaningfully comparable (Lekwa, 2012). If sub-populations interpret the meaning of the *STARS* items differently, then no accurate comparison of groups may be meaningfully constructed. The research on statistics anxiety that consider measurement among subscales is limited. There are, probably, assumptions in previous studies that *STARS* does measure statistics anxiety for all students, equivalently, and these assumption could be incorrect. Therefore, one of the rationales for new studies could be, to compare the level of students' self-efficacy to use statistical procedures across individual characteristics and statistics anxiety. Consequently, an evaluation of whether the measurement is equivalent among different groups of students needs to be assessed, when making group comparisons.

Regarding *experiences in research methodology*, an attempt at an evaluation was conducted. The descriptive findings emphasise that 56.4% of the students scored *good,* while 5.1% achieved *bad* in the scores. An association, with small effect size, was observed between *experience in research methodology* and *SELS beliefs* revealing a statistically important variance in the mean ratings between sets of *average* and *good*. Students with a *good* score in *experiences in research methodology* are associated with high *SELS beliefs*. *Experience in research* *methodology* prepares more students to present positive attitudes. Unfortunately, the contrary was observed in several studies, where no significant linkage was observed between *previous experience* and *attitudes towards statistics* (Coetzee & Van der Merwe, 2010; Zhang *et al.*, 2012; Hannigan *et al.*, 2014).

"Multivariate analysis: What are the factors that significantly predict student's SELS beliefs at the UWC?"

In this section, the researcher sought to explore the results of the Ordinal Regression performed on the UWC data. Using the Cauchit link function the results indicated that *marital status, ethnic group*, and *type of study* were the significant factors among the demographic predictors, selected for the analyses. In addition, the UWC data considered the, *ask for help, worth* and *fear of statistics monitors* factors as individual risk factors of SELS beliefs. The analysis, at multivariate level, revealed that these emotion factors were statistically significant determinants of SELS beliefs.

Regarding the SATS components, *affect* and *cognitive competence* were observed to be statistically significant predictors of SELS beliefs, when an Ordinal Regression was undertaken, in this regard. In addition, the analysis of the UWC data revealed that the *support from family members* could have an influence, in terms of social support and exposure to SELS beliefs.

As discussed earlier in a previous section, *marital status* was a contributing factor of SELS beliefs. The findings of the Ordinal Regression indicated a positive coefficient regression (RC = 2.173), with p =.003. Marital status had a direct influence on SELS beliefs scores.

Concerning *ethnic groups*, the most prominent were African (70.5 %) and Coloured (22.4 %), while the Indian and White students represented only 3.2 % and 3.8 % of the UWC data. The influence of *ethnic group* on SELS depended on the traditional beliefs, as well as the diverse daily social practices and financial constraints. Ethnic practices and norms could influence students' choice of programme, such as the Science department, because of some mystification beliefs. Notably, Coloured students (RC= -

.015) had slightly higher SELS beliefs than students of the White ethnic group did. *Ethnic group, marital status*, and *type of study* were significant predictors of SELS beliefs, using the Cauchit link function. The findings revealed that students from African (RC= 1.831) and Indian (RC= 7.653) had less SELS beliefs, than students of the White ethnic group did.

In sum, these results prove that students from Indian and African ethnic groups were more at risk of SELS than the other abovementioned groups because of some practices regarding their cultural background and their disempowerment. This situation is discouraging, as students are less motivated to devote themselves to producing their best efforts. Other possible explanations could be that students were detached from statistics learning for a period of time, and/or family responsibilities (Bell, 2003). The choices of some students did not reflect reality, which revealed gaps in their attitudes. The African ethnic group live mostly in the disadvantaged areas, characterised by issues surrounding the lack of adequate education. Financial constraints appear to be an important cause that hinders access to education. In an academic institution, such as UWC, where more than 40 % of people live under the poverty line, the influence of parental financial status is quite evident.

The results indicated that full-time graduate students (92%) have less risk of failure to achieve SELS beliefs, than those in a part-time programme (8%). That is a very important finding. The utcomes of the “independent samples t-test” revealed no statistical significance in means difference between part-time and full-time students. There was no significant association between *type of study* and SELS beliefs. The lengthy discontinuities from experience in statistics, and their informal presence on campus, presented great challenges to the learning process of part-time students. Regarding the *type of study*, the results from multivariate analysis also confirmed that it significantly contributed to the improvement of SELS beliefs (RC = -2.386, p = .017).

Notably, only 9% of the students in the UWC data were Non-African. While African and South-African were 41% and 50%, respectively. The results of the multivariate analysis revealed that African (RC = -1.426, p = .189) and South-African (RC = -1.058, p = .257) students had more SELS beliefs, than Non-Africans, who were well prepared. Therefore, the impact of *student status* on SELS was not statistically major in this current research, which also observed in other researches (Abdullah *et al.*, 2015; Yusoff, 2012). The researcher is of the opinion that the students with less confidence in SELS, probably experienced a lack of knowledge. Therefore, providing them with numerous opportunities to involve in investigation, during their advanced educations, could offer them occasions to be bare to statistics, thereby enhancing their self-assurance levels.

In addition, the results of the descriptive analysis revealed that the respondents' score for the "*fear of statistics*" monitors was *no anxiety* (30.1%) and *low anxiety* (39.7%), totaling 69.8% of the respondents, who displayed *low anxiety*. It appeared that when the various tasks illustrated how statistics could be valuable, fallacies about statistics were dismissed. Using the erudition of the relevant articles creates statistics knowledge more expressive.

Subsequently, the results the Ordinal Regression revealed RC = 1.091, p = .023. If the mentor is subtle to students' worries it is likely to assist postgraduate students learn statistics more effectively. Ruggeri *et al.* (2008) reveals that deprived conversation between statistics monitors and students was the key motive for statistics anxiety. Good communication encourages students to relay their most significant queries to the instructors, using a "one-minute paper" approach. In this sense, Chiou *et al.* (2014) assert that the "one-minute paper" meaningfully reduces STARS, by reviewing lessons, which enable them to record their problems, for consultation in the next class, and to re-organise the main points for examination preparation.

Regarding the "*worth of statistics*", the findings revealed that the responses of postgraduate students followed the same trend as *the "fear of asking for help"*. The students displayed *no anxiety* (25.6%) and *low anxiety* (43.6%), totaling 69.2% of students, who displayed low anxiety, which indicates the graduate students' reluctance for referring to peers. A possible reason could be that many students stressed about sharing their point of view; therefore, it would have been helpful to explore more examples, for them to comprehend distinctly in what way statistics could address diverse structures of a problem. The Ordinal Regression results, using the Cauchit link function, confirmed that "*worth of statistics"* is a predictor of SELS beliefs, with a coefficient regression of RC= -1.824, p = .012. In fact, the influence of the "*worth of statistics"* factor on SELS depended on the student's familiarity with different tasks about real world problems. This linkage could be the result of a lack of connection to real world problems for graduate students in statistics. However, this current study determined that SELS beliefs are negatively associated with "*worth of statistics"*. High anxiety levels of worth of statistics are associated with low levels of SELS beliefs.

The univariate analyses revealed that the students reported low ratings in the "*fear of asking for help"* factor, with no anxiety (23.7%) and low anxiety (30.1%), representing more than half of the respondents (53.8%), who displayed lower values. This situation is worse. The outcomes of the Ordinal Regression, using the Cauchit link, exhibited that "*fear of asking for help"* (RC = 1.147, p = .010) was observed to be an important predictor of SELS beliefs. The students were not motivated to ask for any assistance, which implies they may have mistaken beliefs about the applicability of some tests, or interpretations of real world problems. This approach is controversial, and may not help students to develop their own knowledge, or prevent the development of creative brilliance. Likely methods to reduce STARS are through communication and practice, or providing coping strategies to students. To solve these issues, Rodarte-Luna and Sherry (2008) suggest that bordering statistics to students in an approach that assists them to understand influences to their own individual knowledge objectives may assist to reduce STARS in the long-term.

Notably in this current study, it was observed that the students reported a low positive attitude (47.4%) and high positive attitude (21.8%) for *"affect"*. This disproportionate representation in student's attitude reveals a need for intervention to improve their attitude, to overcome their fear. An Ordinal Regression, using the Cauchit link function, revealed a positive influence of *"affect"* on SELS beliefs. Table 6.18 shows that Affect (RC = 1.155, p = .008) implies that a graduate student with a lesser positive attitude is associated with less SELS beliefs, or with a higher positive attitude is associated with high SELS beliefs. This finding is similar to existing literature, as Zhang *et al.* (2012) determined that, among postgraduate medical students in China, the students with more positive *"affect"*, inclined to achieve well in the inspection. Including investigation and statistics into the programme of every student would expose him/her to the language, as well as the meaning that statistics fulfils in his/her development, as experts.

The univariate findings indicated that for "*cognitive competence"* the graduate students scored low positive attitudes (50.8%) and high positive attitudes (20.5%). This situation is probably due to the long periods of time between mathematics or statistics classes. A stepwise Ordinal Regression, using Cauchit link function (RC = -1.210) proved that "*cognitive competence"* was a contributing factor of SELS beliefs, even though there is a negative association between SELS beliefs and "*cognitive competence"* of the graduate students. This outcome is explained by the fact that the deterioration to the mean, denotes to the inclination of graduate students with great positive attitude ratings, to achieve lower on SELS beliefs, students with small positive attitudes ratings to obtain higher on SELS beliefs, and those moderate positive attitude scores for "*cognitive competence",* to score around the moderate range on SELS beliefs. This issue of statistical regression may be a risk to internal rationality. The results of this research is contrary to that of a study by Zimprich (2012), who observed that undergraduate psychology students, from the University of Zurich in Germany, with more positive attitudes towards "*cognitive* *competence"*, as well as those, who were more competent in statistics, revealed higher statistics achievement.

Regarding the social support factor, the results revealed that the respondents' reports for support from *"significant others"* were, disagree (12.8%) and agree (69.8%). The majority of students scored high levels of social support. However, there was no important modification in the means SELS ratings among the support categories (disagree, neutral and agree). A possible explanation for the irrelevant outcome suggests that social support was available for the students, but it did not cooperate as a barrier between the variables, to maybe decrease STARS, or increase SATS. Therefore, support from *"significant others"* may possibly help the student to manage, but not certainly eliminate the issue, modify SATS, or modify rational. Similar results were observed by O'Reilly *et al.* (2010), in an investigation on the emotional happiness and sociocultural reworking among short-term foreign students, from various departments, at a university in Ireland. However, this current study's findings of an Ordinal Regression acknowledged that *support from significant others* remain a contributing factor to improve SELS beliefs (RC = 1.312 with p = .011).

Notably, on behalf of the postgraduate students, inferior levels of STARS were associated with positive SATS. Therefore, as indicated by the results of this current study, the postgraduate programme is expected to direct to lower stages of STARS, and higher positive SATS. However, the current outcomes also revealed that STARS and SATS levels of postgraduate students were similar to those in previous researches (Chiesi & Primi, 2009; Perepiczka *et al.*, 2011; Kiekkas *et al.*, 2015). Since the drive of this current research was not to perform an approach to decrease STARS, or expand SATS, faculty members and others, who plan statistics courses for academic and profession, could integrate resources and methods that will reduce the STARS of students, and, expectantly, direct to improved achievement.

8.3.2.2. Evaluation of the qualitative findings at UWC

The findings were subjected to a thematic analysis. The purpose of choosing an appropriate statistical test counts on the type of the independent and dependent variables to analyse. Additionally, a participant must feel confident and have an interest to be involved in the study. The participants acknowledged being aware that their choice of a statistical test would contribute to the assessment of their level of ability, which eventually would highlight, or reveal the difficulty related conditions. Despite having knowledge about the statistical test, some participants conceded that, they chose a test of convenience, as there was limited information available in the scenarios.

Theme 1: Self-efficacy to choose a statistical test

Three sub-themes emerged from this theme: *Major concerns about the choice of a correct statistics test, Practical knowledge to choose a test,* and *Confident about the decision made.*

- ***Major concerns about the choice of a correct statistics test***

  The findings revealed that the participants experienced difficulty with using their ability, as their inspection of the data, as well as the expected outcomes, limited their flexibility to make a correct choice. This could be due to anxiety that relates to self-focused, negative and anxious reasoning during the learning process. Geary *et al.* (2008) asserts that students with grately STARS often hold comparatively negative SATS, under-report SELS beliefs, when associated to others. This experience was shared by participant 5, who said that he experienced difficulties in performing choice procedures:

  > *"My major concern was the non-understood the data well enough in terms of picking correct test with regards to assumptions particular concept like normality of the data as the aligned assumption generally I did like to go to non-distributed method to non-parametric method I found myself more comfortable with them humm, I feel computing power so I'm*

able to do with non-parametric method because for major concerns.” ***Participant 5***

Similarly, Hembree (1988) argues that, in academic achievement, inferior levels of SELS beliefs are related to greater STARS, as well as greater disparities in task understanding. In this sense, participant 1 acknowledged that the understanding of the data, as well as the expected outcomes, helped him to make the relevant choice.

“*It was the combination of two things, the combination of the data itself; so I was looked at what data was available but and again using the outcomes and match the outcome to the type of the data that was available and I use those two criteria to evaluate.”* ***Participant 1***

All parametric tests adopt convinced principles about the information, also referred to as expectations. Violation of these conventions affects the decision of the investigation, and clarification of the outcomes may be biased (Osborne, 2010). Appropriately, in this current study, the findings indicated that respondent 4 insisted that the knowledge of assumptions, essential in statistical procedures, constitutes a great challenge that could coerce an individual to consult peer students.

“Ok, on the high level for me when doing any research and relating to your research questions what is your objective is looking at the data, the high level questions you have to ask yourself is what type of data am I working on? Is it quantitative or qualitative then you have to look at the variable that you have if the variable spoilers some forms of descriptive, continuous distribution that leads you to the next question if say for example the variable is continuous there is a certain key question you have to ask you have to look at you don’t know how the data for that variable follow some certain normal distribution because the type of statistical tests you do limited to

certain assumptions so if this normal normality or not that's the key question that you have to look at." ***Participant 4***

The participants were concerned, generally, about their experiences in research and statistics, as well as frustrated by their efforts to understand the problem and use these experiences effectively. Their view was that they needed to learn how to use their experiences effectively. The findings of a study conducted by Onwuegbuzie (1997), corroborates this claim, by suggesting that, in general, the failure is due to undesirable practices in preceding statistics courses. This experience causes them to fear statistical concepts, and therefore, they assume that do not have sufficient mathematics exercise to do fine in statistics.

"Ok, at also choosing a statistics test really …humm also goes handling with looking at the type of research you have done that similar to the research you have done and the type of test that was performed for that research it is not necessary one test that could work for the same research there is multiple tests and if there isn't a type of test that would rather serve to your objective you could consult you know with more senior statisticians to come up with a test which could satisfy your conditions." ***Participant 4***

"Eheee, first at all, I tried to remember what I have learnt in statistics and then I looked for keywords that I will identify certain properties or characteristics of certain tests, then I looked at the data that was given, see as the size of the samples something like that, a process of thinking so going back to my undergraduate courses what I have learnt looking at the sample sizes the data that was given and then trying to make a decision based on that." ***Participant 2***

The limited time allocated to complete all the items, also made it difficult to work alone, and thoroughly. However, by working alone, they were in control, and involved in every aspect of their choices.

"I did myself unfair but I did study over items before I did the test. I went over all of them on the computer because I doubt the most of them I gonna pass." **Participant 5**

"Sometimes it was, sometimes I couldn't make the decision because I really didn't know and if it is a real life situation, then you have to do some research. Humm, that is all what we all have to do research to find out you know what is the best test or contact some of your colleagues if you don't know and discuss certain things like that because sometimes somebody else has better information and you have so." **Participant 2**

- ***Practical knowledge to choose a statistical test***

The participants experienced the test as a succession of problems that they had to solve. These problems included the inspection of data and keywords, identification of expected outcomes, interpretation of objectives, delineation of assumptions, application of previous experiences in statistics, checking different possibilities, and choosing the appropriate statistical test. Each item was experienced as stressful.

Concerning the inspection of data and outcomes, it was experienced as frustrating, demanding, and daunting. The participants became challenged and disillusioned. This finding concurs with the theoretical framework, as Canon and Edmondson (2005) postulate that students, who experienced all these above features, are supposed to adapt some strategies during their learning process, such as learning from failures, which is an important facilitator of preparedness for both present and future tasks. Unfortunately, the failure of the students to address the difficulty to select the correct approaches tended to exacerbate this failure in statistics learning.

"*Looking at the type of variables, looking at the data, the difficult thing for me with this questionnaire for me I can ask questions ehee because some of the information yesterday but for me I would want to know more, so I found a little bit difficult actually answer these questions the way I could because I'm the* *type of person that who want do something tiredly that would also took so long."* ***Participant 4***

Regarding the interpretation of objectives and delineation of assumptions, the participants became irritated and pessimistic, especially when they presumed that there was no satisfactory outcome in their choice. This finding concurs with earlier findings, as Ben-Zvi and Garfield (2004) assert that when students are confronted with uncomfortable and unclean data, they do not think beyond the content, given that different possible interpretations are based on different assumptions. Students are misled because their experiences are based on wrong intuitions, errors and misconceptions to provide an appropriate answer, or choose a correct statistical method.

"*It depends on the objective again, so because handling hand with lot of objectives, depend on what you want to answer."* ***Participant 4***

Hoooo, I suppose it could be lack of confidence, in my understanding of a, the data and b, the test itself I think with common test the normal test with the data is it normal can I make the assumptions, with the less common test I would be better talking about assumptions that would making humm without understood the test completely correct." ***Participant 5***

The participants understood that to apply previous experiences in statistics was not an easy task, and that it could be confusing. Although the assumption guidelines helped them immensely, the process does not necessarily advance in a specific and rigid sequence. They had to consider many tasks and decisions, simultaneously, to appreciate the differences. This finding concurs with a previous framework of Schunk and Pajares (2010), who indicate that postgraduate students from different cultural backgrounds have a different understanding and interpretation of data. In the field of learning, students must critically approach new ideas, or concepts. Some of them interpreted these approaches as different from their previous academic environment.

> *"I need to look to data or at least the questions, I could have feeling for what look familiar about it some have very familiar looking something could be a t-test or basic science test, that could be my major decision and then as I went too long, I would realize my power might be very low of my test, so if I had other option, I would consider that test but then I consider alternative test for high power you know to reject the null hypothesis."* ***Participant 5***

> "*I read what information they give me right, and then, what I do I look at the test they gave me right. Now, there are certain information in the problem that they give me, like I would look at like say even they have given like a correlation and I will look at those tests where I know they make use of correlation Ok."* ***Participant 3***

The students understood that making a choice of a test was not merely a rational process, but that external events may be of great value to enable the task. In all, they broadened their insight into, and their comprehension of, the nature of the event, as they experienced practical statistics, personally. Ultimately they assumed that they were well informed about the items, and better prepared to participate in the study. This finding concurs with those of Stein (2014), claiming that creative students are self-confident. Therefore, once they had solved a specific item, they were motivated, as well as confident about continuing, and more relaxed. Initially, they believed that choosing a statistical test was something they could merely pick and be done with: however, they later discovered that there was more to decide on than they thought. Consequently, they became worried and afraid of making mistakes.

> "*Eheee, first at all, I tried to remember what I have learnt in statistics and then I looked for keywords that I will identify*

certain properties or characteristics of certain tests, then I looked at the data that was given, see as the size of the samples something like that, a process of thinking so going back to my undergraduate courses what I have learnt looking at the sample sizes the data that was given and then trying to make a decision based on that." **Participant 2**

"I suppose to the similar previous answer I think my decision was based on I will give maybe three reasons naturally just considering a type of question so giving or making assumption about the distribution taking a looking at any kind of possible weaknesses in the model or non-normality or the skewness of the distribution could be a possibility then I considered power in terms of rejecting for promises." **Participant 5**

- ***Confident about the decision made***

The participants initially underestimated the level of proficiency that this type of task required. The postgraduate students were either very confident or positive, because they perceived the task as relatively simple and straightforward. This finding concurs with that of Garfield *et al.* (2007), who argue that previously, learning approaches were more passive for students, which they had to implement in their lives by continuously repeating the process until they were confident enough.

"I'm considered very confident." **Participant 5**

"Hauf, I feel very confident. This, I am core confident." **Participant 1**

Students were under the impression that they knew what was expected of them, or they felt unsure, unable, and unwilling to become involved, doubting their ability to assume the responsibilities of a statistical test choice on their own. Boud (2013) emphasises that the student has to discover his/her own issues, aptitudes and solutions.

"The easy ones, I'm very confident; …humm the ending are the difficult ones because there were possible choices. Ok, I don't use the parametric tests a lot which is applicable to normal test also, so I rather went for the easier test which is a normal assumptions and I stay away from the non-parametric test." ***Participant 3***

"The ones that I have answered I'm confident, some of them I wasn't very sure but I didn't know which other option to select. So some of them I took a guess especially with the comparing of the mean questions I took a guess there; humm yah I wasn't exactly sure about that one." ***Participant 2***

However, the perception of the participants changed as the task progressed. When they took the initiative to make their own decisions, they experienced a personal revelation. They discovered hidden qualities and strengths in themselves, and they experienced the personal progress of their self-efficacy. Similarly, by considering the students' ability, this current study confirmed the findings achieved by Ally (2004), who observed that students tend to interpret the new information, in terms of the knowledge they already hold, constructing their own meanings, by connecting the new idea to what they already believe.

"Look, I didn't spend too much time and I couldn't ask a lot of questions on the scenarios and I'm feeling confident I think, really." ***Participant 4***

Unfortunately, some of the participants encountered conflicting choices, contradictions and doubt in their decisions. They sensed that they needed support from peer students and senior statisticians, and became disillusioned when the expected help did not materialise, but very grateful when they did receive help. This finding is logical and is largely consistent with a significant body of literature, documenting the collaborative mentor-apprentice model that is applied for post-graduate instruction

(Andersson *et al.*, 2006; Reed, 2010). Regardless, the supervisor still holds a prime position, acquired by training, maturity, and knowledge.

> *"If there isn't a type of test that would rather serve to your objective you could consult you know with more senior statisticians to come up with a test which could satisfy your conditions."* ***Participant 4***

> *"Sandler's A statistics, I haven't seen it in my life; the rest I'm familiar with it but I wasn't able to use them in my answers, I wasn't confident enough."* ***Participant 5***

> *"For some scenarios it's easy you can be confident … the more complex objectives, the more conflicting your choices would be in terms of your decision … you will come up with non-sense statistics."* ***Participant 4***

Despite the fact that participant 5 tried to access the information via the network, before completing the task, he was still not confident enough about the selection.

> *"I did myself unfair but I did study over items before I did the task. I went over all of them on the computer because I doubt the most of them I gonna pass."* ***Participant 5***

Theme 2: Perceived failures to choose the right test

Little attention has been paid to the question on how to select a right statistical test in an academic environment. The process of the above task involved some difficulties that the participants experienced. In this current study, the researcher was concerned about the perceived failures to choose a correct statistics test. The participants realised that their choice of a statistical test could eventually reveal some difficulty related conditions. Two sub-themes were generated from this theme: *Causes of difficulty to choose a statistics test*, and *Reasons for rejection of some tests.*

- ***Causes of difficulty to choose a statistics test***

The learning process is valued by the knowledge quality, or skills acquired, or the level of understanding of the basic concepts of statistics. The findings indicated that the participants were often anxious about their difficulties to choose the relevant test. However, the results were quite interesting, from the participants' perspective. The difficulties observed during the task practical, might be due to several factors, including, lack of information, lack of knowledge, real life problem, non-familiarity with the items, mis-understanding of the items, confusion in interpretation of concepts, conflicting concepts in statistics and different areas of expertise. These results were not consistent with earlier findings. Garfield and Ben-Zvi (2007) determined that the learning process guides students to become aware of, and confront their misconceptions. These results make intuitive sense, in view of the fact that lack of information was reported by three participants.

> "*Yes, there were some tests which is difficult to decide …humm because it's not a lot of information is given but a very last one where they give the observed, I wanted to apply a chi-square test but because the keyword in this correlation, you can't apply the chi-square to really a correlation, so I look at the other possibility of the correlation test.*" **Participant 3**

> "I*n fact the information was not completed in terms you didn't see the data if you could plug it you could make it feel a little bit more comfortable or you could run a little bit of pre-test on it you feel little bit more comfortable.*" **Participant 5**

> "*I wasn't familiar with all of the tests so I couldn't decide what to use maybe to just little information to me to make a decision.*" **Participant 2**

The participants faced difficulties to choose a correct test because of the lack of knowledge to complete of some specific items. The students became discouraged, since their accomplishments required tenacity, determination and commitment. The findings of a study conducted by Brophy (2013) corroborates this claim that their achievement without motivation and construction of a work environment, was impossible

> *"Sometimes it was, sometimes I couldn't make the decision because I really didn't know and if it is a real life situation, then you have to do some research. Humm, that is all what we all have to do research to find out you know what is the best test or contact some of your colleagues if you don't know and discuss certain things like that because sometimes somebody else has better information and you have so. Sometimes I didn't know honestly, I didn't know what to do, so I just left that, I didn't know what to choose."* ***Participant 2***

> "*Yes, most of the tests that were available are not my special; they are not tests that I usually used so yes it was little bit difficult to decide."* ***Participant 1***

> "*I think just the lack of exposure to certain kind of techniques, I think I haven't for a long time use some techniques, some I have never been exposed to certain book of reading."* ***Participant 5***

Misunderstanding and unfamiliarity of the items were also another source of difficulty, which affected the ability of the participants to select a relevant test. Nicol and Macfarlane-Dick (2006) argue that the engagement of the student with the task requires previous knowledge and beliefs, his own clarification of the sense of the task, and its supplies. Participant 2 mentioned that she was not able to select the right test, due to some limitations, such as lack of awareness, knowledge and inexperienced to do such tests. The following evidence refers:

> "*Humm, maybe that it wasn't difficult to choose, just say maybe I didn't know all of the statistical tests are there; I wasn't familiar with all of the tests so I couldn't decide what to use*

maybe to just little information to me to make a decision." **Participant 2**

Additionally, scientists have been known to fool themselves with statistics, due to the lack of knowledge of theories, and the lack of standardisation of their tests ((Teddlie & Tashakkori, 2011). In this sense, the master's student participant 3 claimed that, because the keyword in the item was correlation, he merely looked at other possibilities of correlation without checking the assumptions; evidently, he was confused about his procedure, and could not make a useful assessment.

"Yes, there were some tests which is difficult to decide …humm because it's not a lot of information is given but a very last one where they give the observed, I wanted to apply a chi-square test but because the keyword in this item was correlation, you can't apply the chi-square to really a correlation, so I look at the other possibility of the correlation test and since, there I'm using the scenario that I'm not familiar with so that one was difficult." **Participant 3**

Furthermore, when dealing with concepts and interpretation accordingly, it is significant for the investigators to appreciate the basic concepts of the testing procedure, in order to make sound decisions about choices, results and to draw accurate conclusions.

"There is so many conflicting concepts in statistics you know certain statisticians believe, some people believe qualitative data can actually be quantitative because you should code, there is lot of debates around certain key concepts in statistics so it could be very confusing especially if it is not something you do daily; that's so I found because I'm newly back into this field again." **Participant 4**

"Look if your scenario has a certain nature where, if multiple variables and there is especially when you can identify multiple tests that could be used for the same scenario that for me I

could you know difficult to decide, for me then I would rather do let's strobe wait and see and then logically loud it out." **Participant 4**

Data manipulation is a serious issue in statistical analyses. It is important to understand the data, concepts and fixing real problems, before choosing the right test to apply. However, participant 2 revealed that effective participants, with amendable shortcomings, should be assisted and guided to complete the tasks.

"*Sometimes it was, sometimes I couldn't make the decision because I really didn't know and if it is a real life situation, then you have to do some research. Humm, that is all what we all have to do research to find out you know what is the best test or contact some of your colleagues if you don't know and discuss certain things like that because sometimes somebody else has better information and you have so. Sometimes I didn't know honestly, I didn't know what to do, so I just left that, I didn't know what to choose."* **Participant 2**

In addition, in Table 8.1 the area of expertise posed a challenge for the participants, who relied heavily on their prior experiences in statistics. Statistics has different fields of specialization. Participants 1 and 4 reported that not belonging in a specific field, may lead to the narrowing and distorting of the expected outcomes.

"No, because unfortunately I haven't test any of these tests and it wasn't in my area. Unfortunately, no I only use what was given to me to analyse which test to use." **Participant 1**

"Look at it, is difficult in the sense especially you don't work with certain scenarios on the daily basis or it is not your area of expertise within the statistical field that's make it very very difficult." **Participant 4**

- **Reasons for rejection of some tests**

Overcoming the rejection of some statistical tests has proven to be very difficult, and many questions remain unanswered for many decades. In this current project, various reasons for rejection emerged, including lack of knowledge, lack of information, misunderstanding of the concepts, confusion, assumptions do not allow, less evidence, do not satisfy criteria for the test and referring to peer students.

Regarding the lack of knowledge, the participants were baffled, not knowing what to do. Participants 1 and 2 became frustrated, as they were not able to establish an appropriate solution. Bandura (2012) reveals that a student becomes more effective, when he refines the feedback, by interpreting the task, or adjusting internal goals, tactics and strategies. Even the revision of a student's field of knowledge, or motivational beliefs, is necessary, in case it influences subsequent self-regulation.

> "M*ost of the tests that were available are not my special; they are not tests that I usually used so yes it was little bit difficult to decide."* ***Participant 1***

> "*Sometimes I didn't know honestly, I didn't know what to do, so I just left that, I didn't know what to choose."* ***Participant 2***

> *"Humm, maybe that it wasn't difficult to choose, just say maybe I didn't know all of the statistical tests are there."* ***Participant 2***

Another concern raised by the participants for their failure to reject some of the tests, was the lack of information, which created confusion and affected their achievement. In this regard, Redmond (2010) claims that the individual self-efficacy is great in a specified extent, and meanwhile s/he has a great self-assurance, s/he is more probable to attempt harder to achieve the task with abundant well result.

"but because of lack of information in the scenario, you can really now say easy that one you know in real life you just apply the different alternative; but in this case, there wasn't a plan where you can ask for extra information." **Participant 3**

"*I wasn't familiar with all of the tests so I couldn't decide what to use maybe to just little information to me to make a decision."* **Participant 2**

In addition, the misunderstanding of the concepts also increased the frustration and confusion of the participants, in their approach to the tests. It was obvious that the degree of errors was likely to be high in their achievement.

"What does invented data means?"; *"…rather it should have been Z score than Z statistics or Z-test; it would be better than Z statistics let's put like confusing*." ***Participant*** **3**

The complexity of many statistical ideas, assumptions and rules, constitute major challenges for students to ascertain the degree to which the choice provides the desired outcomes. These include, assumptions do not allow, do not satisfy criteria for the test, and less evidence, which heavily influence the rejection of some of the tests. Garfield *et al.* (2007) argue that when students are not familiar with the concepts, or maybe, the way students think about data, it causes them to fail, in confusion.

"I would often reject because I sound realise certain assumptions do not permit or allow and then there was not enough power." **Participant 5**

"If it doesn't satisfy the criteria for the test, you know. You can do a t-test if there is no…whatever…" **Participant 5**

The one believes that the data (independent variables) determine the effects observed on the dependent variables. The other attempts to understand a problem, but does not effect a change. The results are interesting when the participants are from diverse backgrounds. The difference between the best and the worst choice might be due to several factors, such as, a degree of familiarity with a specific test, the ability to select an adequate test, the ability to solve it, and the ability to apply prior experiences.

Theme 3: Non-familiar statistical tests

In this section, the attention is focused on the familiarity with statistical tests. The challenges arose because of the influence of the participants' multiple backgrounds on their learning processes, and the difficulty of unravelling the contributions of multiple approaches of teaching over time. These findings support earlier findings, as Lunenburg (2011) argues that the self-efficacy beliefs influence the students' aptitude to study, their incentive and their achievement, as individuals will frequently strive to study and complete merely those tasks, which they trust they will be fruitful at. Changes in the strategies of learning might reflect differences that could be observed in the various characteristics of students, from one year to the next. Redmond (2010) claims that the principle after the SELS beliefs theory is that achievement and incentive are, in part, solved by in what way active students trust they can be. Notably, examining the accuracy of the participants' responses in this current study, it was evident that, even among participants with the same level of knowledge, exposed to the same programme and reality (teaching statistics courses in undergraduate level), there was a variation in what they understood *a statistical test* to be, and its usefulness.

> *"In terms of the tests? Post-hoc test for comparison of means, Factor analysis, Discriminant analysis, Semi-partial correlation, Kruskal and Wallis for One-way ANOVA for ranked data, Friedmann Two-way ANOVA for ranked data, Path analysis and Sandler's A statistics".* ***Participant 1***

> *"Ok, I will start at the bottom, the number 34 a Sandler's A test; Path analysis; the Fischer exact probability test; Discriminant analysis, the Sign test, I'm not familiar with. Fisher z transformation, Factorial ANOVA, I'm not familiar with the Post-hoc test comparison of means that's number 12 but I guess that one because just because of the*

words …humm, what else's. The Partial and Semi-partial correlation I'm not familiar with together that's all it". **Participant 2**

"Yeah, Path analysis, Friedman, Two way, Sandler's A statistics, Discriminant analysis". **Participant 4**

"I little be confuse in, between 28 and 20 (Partial correlation and semi-partial correlation), I have been exposed to it but I don't remember the difference, I read that but I haven't convince of my understanding. Sandler's A statistics, I haven't seen it in my life the rest I'm familiar with it but I wasn't able to use them in my answers, I wasn't confident enough". **Participant 5**

8.4. Discussion of the findings' combined data

8.4.1. Assessment of quantitative findings' combined data

8.4.1.1. Assessment comparison of each variable across universities

The previous chapter (Chapter 7) deals with the comparison of variables across UCT and UWC, using Chi-square, Phi and Cramer's V to test associations. To ascertain each of variables the following research question was formulated:

"What is the association between the academic institution and each of the variables, namely, individual characteristics, experiences, STARS, SATS, social support and SELS beliefs?

This question facilitated the assessment of whether the value of each of the categories of the above variables was similar, or different between the two institutions. According to the findings of the data analysis, in the gender test, the percentage of male students at UWC (51.3%) was lower, compared to UCT (76.8%), as indicated in Table 7.10. Female students represented 48.7% at UWC, higher than 23.2% at UCT. The results for the Chi-square, as depicted in Table 7.10, revealed that there was a important connection between the gender and academic institution. A possible reason for this decrease between UCT and UWC among male students might be due to South Africa's strong economic activities, presenting better employment opportunities, as the majority of male students are keen to join the workforce at an early working age. As there was a variance in the proportion of gender across universities, the results further revealed that the percentage of males decreased, while that of females increased. However, postgraduate male students still constitute a higher proportion. The increase in females may be due to feminisation of education in Africa, while women have started to engage in seeking better employment opportunities, after finishing their programmes, as well as various other reasons. This feminisation process is more pronounced in UWC than at UCT. However, educated women are not homogenous; therefore, their reasons for improving their level of education in South Africa vary. Besides joining the labour force, others study for reasons such as, seeking better education and social networks.

Additionally, there were decreased rates of students in the 20-25 and 26-30 age groups between the universities, as depicted in Table 7.10. Similarly, increased rates of students were achieved in the 31-40 and 41+ age groups, as indicated in Table 7.10. These increases and decreases may be a consequence of UNESCO that encouraged countries to adopt changes in learning from original and traditional approaches. Due to the multilateral cooperation in education, postgraduate students have immigrated to South Africa to further their education, in order to provide a better life for their families in the future. Even though there was an increase in the number of Black students, who entered the South African universities, there were fluctuations and incidents that occurred within universities. The institutions were marked by economic, social and political events. According to the Industrial Development Corporation (Republic of South Africa [RSA], Industrial Development Corporation, 2013), there was a global financial and economic crisis in 2007, which later led to a recession to the South African economy in 2009. In addition, in 2008 South Africa experienced xenophobic violence that drove some students back to their countries South African government introduced the Immigration Act (Republic of South Africa [RSA], Act No.13 of 2002) to attract migration of qualities. These abovementioned events instigated amendments to the act, followed by a new Act on migration in 2011 (Republic of South Africa [RSA], Immigration Amendment Act No. 13 of 2011), which came into effect in 2014.

Based on this new regulation, it is anticipated that the proportion of Black students is likely to decrease in the coming years. In addition, the recent 2015 xenophobic attacks across South Africa may also drive down the influx of immigrant students. The recent 2015 and 2016 strikes across South African universities may also drive down the influx of immigrant students. Additionally, postgraduate students enumerated in the 31-40, as well as the 41 and above age groups were substantial in proportion at UWC, while those enumerated in the 20-25 and 26-30 age groups were considerable in proportion at UCT. The results for the Chi-square, as illustrated in Table 7.10 show that age group is significantly associated ($P= .011< .05$) with the academic institution. The likelihood of postgraduate students attending an academic institution, varied with age group. The findings from the data revealed that the probability of them attending UCT increased with young students, while at UWC it increased with adult students, suggesting that, as students advance in age, the likelihood of them attending university, increased at UWC. The results in Table 7.10 are in line with a study conducted by the Dakar Framework for Action (World Education Forum, 2000), which postulates that young and adult people are required in academic institutions, over reasonable entree to suitable knowledge and life abilities platforms, achieving the commitment to ensure effectiveness and efficiency in all aspects of education.

In line with the ethnic groups of postgraduate students, the following question was formulated: ***What is the association between academic institution and ethnic group of postgraduate students?*** The results in Chapter 7 attempt to answer the above question. Table 7.10 reveals that the attendance of Black and Coloured students is more representative at UWC compared to UCT, where the attendance of Indian and White students is higher at UCT, than at UWC. Morrow (2008) emphasizes that a possible reason could be that Black students with poor qualifications and financial constraints are likely to be excluded, as merging different universities does not address differences in the educational preparation and financial backgrounds of students. The purpose of this question was to identify the most represented ethnic groups at both universities. The results for the Chi-square, as shown in Table 7.10, reveal that ethnic group is significantly associated (P= .000 < .05) with the academic institution. The likelihood of particular postgraduate students attending certain academic institutions varied with ethnic group; however, the data revealed that the probability of attending UCT increases depending on whether student is Black or White, while at UWC the increase would depend on whether student is Black or Coloured. For both universities the majority of students were enumerated in the Black group, which may be due to South African government's promotion of equity and quality in education. Woodrooffe (2011) acknowledges that established universities maximize the students' ability to contribute to their integration in their academic environment, and facilitate their social cohesion by implementing the ethical environments and multiple trainings (workshops, conferences, and oral presentations).

In statistics learning, STARS is often used as a proxy to measure the level of statistics anxiety, in order to achieve performance activities; therefore, it plays a critical role in the statistics learning. The research question related to the variable is, '***What is the association between academic institution and overall STARS of postgraduate students?***' The results in Table 7.10 illustrates that the majority of students scored low anxiety levels at UCT, compared to UWC, followed by those with moderate statistics anxiety levels at UWC compared to UCT. The "Chi-square test for independence" designated that the depicted relationship between the students' levels of overall STARS and the academic institution was statistically significant, where the probability of the chi-square test statistic (X^2= 13.170) was p=0.001 (fewer compared to the alpha level of meaning of 0.05), and the effect size for this finding was small (Cramer's V=.21). This implies that, across the two universities, statistics learning produced postgraduate students of quality with less statistics anxiety, which is reliable by the conclusions of Hsu *et al.* (2009), using wired students to observe the stages of STARS, and may indicate the beginning of an original track of STARS research that emphases on computer-generated settings.

Regarding the link between student level of STASTATS anxiety and the academic institution, the "Chi-square test for independence" demonstrated that the portrayed relationship between the students' level of STASTATS anxiety and academic institution was statistically significant, where the likelihood of the chi-square test statistic (X^2= 15.622) was p= .000 (fewer than the alpha level of meaning of .05), and the effect size for this finding was small (Cramer's V=.23). Therefore, in conclusion, there is a lesser risk of statistics anxiety among postgraduate students. However, in reality, this result can be explained by the multiple opportunities offered to postgraduate students to attend seminars, workshops, trainings, availability of statistics monitors and peers to assist students with issues related to their data analysis. It is clear that each university has specific approaches to assist their students with statistics anxiety. Another possible explanation could be that, as the STARS survey was self-reported, students might have underestimated their STASTATS anxiety level, as they might have been concerned about appearing partially ignorant, and might have reported incorrect information. This finding resonates with earlier research findings by Williams (2014), which suggest that graduate students, who want to be socially accepted, often feel under pressure to under-report their levels of statistics anxiety.

According to Bandura (2001) and Kolb (2014), the experiential opinion of knowledge emphasises that knowledge can be upgraded if effort is added deliberately, responsibly and fewer recurrently. This section attempts to response the following investigation query, '***What is the association between academic institution and level of effort postgraduate students?***' The drive of this request was to control whether the level of effort of a student differs from one academic institution to another. The results of the association between the aforementioned variables were described in Table 7.13. The majority of the respondents scored the highest positive attitude for *"effort"* at both universities; however, UCT was higher than UWC on percentage. In contrast, students who reported a low positive attitude followed a different trend with UWC greater than UCT, while those who registered a moderate positive attitude were greater at UCT compared to UWC. About two-thirds of the postgraduate students with a positive *"effort"* showed that it would be suitable in their upcoming profession (68% for UWC and 71% for UCT) and is important for graduate and postgraduate studies.

The "Chi-square test for independence" verified that the connection between student level of *"effort"* and *academic institution* was statistically significant, where the likelihood of the chi-square test statistic (X^2= 6.175) was p= .046 (fewer than the alpha level of meaning of .05) and the effect size for this finding was small (Cramer's V=.14). These findings provide evidence that the students' level of *"effort"* differ in relation to the *academic institution*. In support of these views, Griffith *et al.* (2012) argue that many students may be motivated to attempt postgraduate studies, in order to achieve more employment options. It may be the situation that engineering and business students, for instance, have illustrations that are straight convenient to a tangible environment, in which the student may shortly effort. Also, it is likely that students possibly will have an easy understanding of the practice of statistics in the precise arena they possibly will follow.

Social support determines the student's human potential or capabilities, which, in turn, empower them to engage in new patterns of participation in the socio-economic and political spheres of education. This current research investigated the associations of postgraduate students' support from *"friends"* and the *academic institution*. The scores from Table 7.14 identified that every of the above-mentioned variables generated associations among each other. The students reported the highest level for support from friends at both universities, with UCT (81.5%) higher than UWC (71.2%) on percentage, indicating that it was an influential factor in their lives and revealing the challenging situations they experience (coping with making friends, transportation, and climate) without incapacitating anxiety.

Additionally, the results for the "Chi-square test for independence" designated that the depicted association, as shown in Table 7.14, of support from friends was significantly associated (X^2 = 6.126, P= .044< .05) with the academic institution. The likelihood that postgraduate students would receive support from friends varied with the academic institution. However, the data indicated that the probability of students receiving support from friends was greater at UCT than at UWC. This conclusion is consistent with current writings, as O'Reilly *et al.* (2010) observed that, at a University of Ireland, intercontinental students had significant higher stages of social support, compared to the Irish students. Additionally, the finding supports those of Yusoff (2012), which reported that students in a Malaysian public university had significantly greater levels of support from *"friends"* and *"significant others"*. However, support from *"friends"* may help students to manage, but not essentially eliminate the issue, or transform their rational.

Approximately four-fifths of the postgraduate students recorded the highest level for overall social support, indicating that most of them assumed to have adequate support (80.8% at UCT and 78.2% at UWC). The students were strongly of the opinion that support was important for postgraduate studies. This revealed that they were experiencing many difficulties, such as accommodation, food, job and communication. However, the students with the lowest level of the overall social support were greater at UWC than at UCT. In addition, the "Chi-square test for independence" confirmed that the connection between the students' level of *overall* social support and the *academic institution* was statistically significant, where the likelihood of the chi-square test statistic (X^2= 6.081) was p= .049 (fewer than the alpha level of meaning of .05), and the effect size for this finding was small (Cramer's V=.14). These findings indicate that the students' levels of overall social support differed between UCT and UWC. This finding also supports the existing literature of Abdullah *et al.* (2015), who observed that social support components are important predictors of emotional transformation during multicultural conversions for international graduate students in Malaysia, indicating that socio-cultural adjustment in a collective educational setting means socialising with the host residents. Therefore, social support may possibly help, not automatically eradicate the challenge, but adjust the way of learning.

8.4.1.2. Assessment of the impact of the predictors on SELS across universities

In this section, the researcher aims to address the following examination query: ***'What are the similarities or differences on the SELS beliefs per individual***

characteristics, emotion, behaviour and social support across universities?' The purpose of this question was to explore the means difference of the SELS beliefs among the groups. The importance of this knowledge helps to explore the association between SELS beliefs and possible predictors.

Regarding postgraduate programmes, the descriptive analysis revealed that 61.5% Masters and 38.5% PhD/post-doctorate students were enrolled at both universities. Furthermore, an "independent-samples t-test" exposed a statistically substantial difference in the mean ratings for SELS beliefs between *masters* and *PhD/post-doctorate* students at 95% with M = .242, 95% CI: [–.056, .428], t (302) = 2.562, p = .011, two-tailed. The PhD/post-doctorate students probably considered that statistics was a subject they would rather not engage with, as they deemed it pointless in their future careers. Another possible answer could be that these students may have encountered difficulties with applying statistics to real world problems, because of prior bad experiences. In this sense, Onwuegbuzie (1977) explains that the failure is due to misperceptions and misunderstandings of statistics concepts, and negative experiences in previous tasks. These negative experiences cause students to be apprehensive about statistical concepts. Often, students are not confident that what they learnt in mathematics training would be of any use to them in statistics classes. This fear of failing often delays the completion of degree programmes. However, the masters' students were proud to access research in an academic world throughout their programme of study.

Despite these misunderstandings, 68.70% of the postgraduate students reported the highest category in research methodology. Experiences in research methodology indicated a statistically important means change in the groups, with a small effect size, F (2, 304) = 3.848, p = .022. There was a positive association between SELS beliefs of the graduate students and their experiences in research methodology. The students' responses to the experiences in research methodology indicated a positive belief in applying it to real world problems. Overall, their self-efficacy and experiences in research methodology seemed to represent a self-fulfilling prediction, which graduate students adopt when learning statistics, which is alike to the findings of Williams (2014), who claims that postgraduate students, under stress to seem publicly needed, may over-estimate their stages of STARS, as well as their levels of achievement.

Therefore, statistics anxiety among students might manifest differently at UCT, than it does at UWC. The SITSTATS score represents a total score of *"worth of statistics"*, *"interpretation of statistics"*, and *"test and class"* anxiety. The STASTATS score describes a total score of *"computational self-concept'*, *"fear of asking for help"* and *"fear of statistics"* monitors. STARS score is a total score of SISTATS and STASTATS.

Regarding the SITSTATS in Table 7.3b (see Appendix A), the univariate analysis indicated that 56.4% of the graduate students scored low anxiety, against 7.2% with high anxiety. In addition, the findings of an independent samples test showed that the mean difference = .622, 95% CI: [.339 to .905], p = .000, two-tailed; was statistically substantial, and the variance observed in the mean ratings was moderate (eta squared = .06). Students with low anxiety in SITSTATS are associated with high SELS beliefs scores. A possible explanation could be that the development of knowledge, which these students apply in statistics, enable their emotion, self-control. Bell (2003) established similar results in a study at a USA University, confirming that, traditional postgraduate students may experience low levels of anxiety, compared to non-traditional postgraduate students, simply because, while using the same learning strategies, they are more conversant with a certain number of strategies. Another reason could be easy communications between the students and the statistics monitors. According to Beurze *et al.* (2013), second year students, who scored higher in statistics, displayed lower anxiety on the STARS scale.

For the STASTATS results, the descriptive findings in Table 7.3b (see Appendix A) reveal that 79.8% of the respondents scored low anxiety, compared to 4.2% who scored high anxiety. In addition, an independent-samples test revealed an association between STASTATS and SELS beliefs. The mean difference = .807, 95% CI: [.400 to 1.214], p = .000, two-tailed, was small (eta squared = .05). Therefore, students with low SELS scores are associated with high anxiety scores in STASTATS. As all the instruments applied were self-reporting, and therefore, issue to unfairness, the students possibly will have over-reported their levels of SELS beliefs, in order to appear socially desirable. This finding is consistent with the research of William (2014), who claims that social status influences the attitudes of graduate students, which increases bias, and impacts negatively on their SELS beliefs.

While testing for STARS, the univariate analysis, illustrated in Table 7.3b (see Appendix A), indicated that only 3.3% of the respondents reported high anxiety in STARS, compared to 72.3% with low anxiety in STARS scores. However, the outcomes of an "independent samples t-test" revealed that there was an association between STARS and SELS beliefs. The mean difference was = .809, 95% CI: [.500 to 1.119], t (305) = 5.142, p = .000, two-tailed, with a moderate magnitude effect (eta squared = .08). One of the possible reasons could be the measurement issues. Hutchinson *et al.* (2008) explains that the mean differences in statistics anxiety, across different groups, could be seen as the measurement of items, rather than the real differences in the perception of statistics anxiety, without a measurement equivalent. Unfortunately, if sub-populations interpret the meaning of the STARS items differently, no accurate comparison of groups may be meaningfully constructed. Probably, this assumption may be incorrect. Therefore, one of the rationales for a new study could be to compare the level of students' self-efficacy in using statistical procedures across individual characteristics, as well as statistics anxiety.

Considering the support from significant others, the descriptive analysis revealed that 10.1% of the students disagreed, compared to 73%, who agreed. The majority of students received support from their significant others. However, the findings determined that the probability of students receiving support from significant others is substantial. In addition, results of a "one-way ANOVA test" discovered a statistically substantial means change in the three groups of support from significant others, with a small effect size, F (2, 307) = 4.004, p = .019. This situation seems to indicate that students endure many shortcomings, in terms of transport, climate, communication and jobs. This conclusion is consistent with standing writings, as (Abdullah *et al.*, 2015) also observed that social support is a prognosticator of emotional variation, during multicultural conversions for universal graduate students in Malaysia. This finding indicates that socio-cultural adjustment in a shared knowledge setting implies socialising with the host residents.

For support from friends, the findings of the univariate analysis indicated that 8.1% of the students disagreed, while 76.3% agreed to receiving support from this source. Approximately, three-quarters of the students received help from friends, which is crucial, because of the difficulties they encounter on their journey. Therefore, according to the findings, the likelihood of postgraduate students receiving support from friends is quite high. Additionally, the outcomes of a "One-way ANOVA test", present F (2, 307) = 3.515, p = .031, revealing a statistically significant means difference in the groups of support from friends. Students consider support to be a key factor in postgraduate studies. This outcome is consistent with prevailing literature, as O'Reilly *et al.* (2010) observed that, at a University of Ireland, international students enjoyed significant higher levels of social support, compared to their Irish counterparts. Regarding students in the Western Cape, South Africa, many of them originate from peripheral areas, or the surrounding provinces, such as Eastern Cape, Northern Cape, as well as the Northwest, among others. These students face many challenges such as accommodation, food, jobs, as well as making friends.

8.4.1.3. Assessment findings multivariate combined data

"*Multivariate analysis: What are the factors that significantly predict student's SELS beliefs using the combined data of both universities?*"

In this section, the researcher evaluates the results of the best ordinal regression model assumed in the combined data, using the complementary log-log link function. The assessment revealed that "*experiences in statistics*", "*effort*", *ethnic groups*, *marital status* and *postgraduate programmes* were the significant factors among the predictors selected for the analysis. Applying the standard of parsimony to the building of the best model, the combined data included all the selected predictors. The ordinal regression, using the complementary log-log link, was the best choice. The theory of similar lines was attempted and the pseudo R square was the best, with the greatest amount being Cox and Snell (1989) at .60, while the model also indicated a high prediction accuracy of 60% for combined classes. Regarding the estimated arrangement probability for the best model, a strong positive correlation between the predicted and the actual category was observed, with rho = .606, $p < .000$, $n = 243$. The strength of the relationship was 36.72%.

The complete model, with the paired log-log link function, developed the greatest model, founded on the following measures: fitting statistics, strength of model hypothesis, correctness of the arrangement outcomes, norm of stinginess and the steadiness of restriction estimate. Main inquiry conclusions should be drawn from the greatest model. "*Experiences in statistics*", "*effort*", *ethnic groups*, *marital status* and *postgraduate programmes* were the significant predictors of SELS beliefs. It provided the convincing evidence that individual characteristics, such as *ethnic groups*, *marital status* and *postgraduate programmes* have played an important role in generating a satisfying predisposition setting influence on students' SELS beliefs. In addition, the "*effort*", regarding behaviour prevention was significantly associated with the SELS beliefs. This provides evidence that one component of behaviour directed the students' needs, and participated to the fulfilment of students' goal, namely, a positive attitude towards statistics. Additionally, the "*experience in statistics*", concerning the experience predictor, was significantly associated with SELS beliefs. This indicates that one constituent of the *overall* experience directed the requirements of students' experience.

This current investigation should be observed as an main first stage for the university to discover the connection between SELS beliefs and multiple explanatory variables, including *ethnic groups*, *marital status*, *postgraduate programmes*, *effort* and *experience in statistics*. The knowledge gained from this study should be beneficial for UCT, UWC, as well as its students. The goal was to create standards that could be supportive to decision-makers in academic institutions, to improve higher education. The application of the principle of parsimony in this current study was an opportunity to shape the aspirant models, and search for the finest model.

8.4.2. Summary of the evaluation of the qualitative findings at UCT and UWC

A discussion of the qualitative findings of both the universities seemed most significant. Although, moving away from the shared intellectual journey, with the self-efficacy beliefs to apply statistical procedures, attention should be paid to the deviousness, and to some extent the unpredictability of both the institutional and regional borders. Both universities have shed significant new light on what was similar, or different, about the collective systems, as well as the reasons behind the similarities and differences.

Regarding UCT, the findings indicated that students had trouble with choice procedures because of the lack of information in the scenarios, the lack of practical knowledge, the misunderstandings of the concepts, or the fear of asking for help, among others, during the learning process. In this sense, Laurillard (2013) reports that the external activities of the learning environment tend to influence the internal cognitions of the students. Some participants observed that examining previous data and experiences assisted them to make a meaningful choice. However, other participants became irritated and disillusioned. This finding supports earlier findings, as Pintrich (2004) asserts that students, who have experienced all these characteristics, should adapt certain strategies during their learning, such as learning from failures. Regrettably, the failure of students to solve the difficulty of selecting the correct approach tends to be recurring in statistical learning. Students have to reconstruct knowledge within a particular context. Validity is achieved by drawing a connection to the real world, such as experiencing the students' everyday life, practicing in the discipline, and by transforming knowledge.

The participants also understood that the application of previous experiences in statistical procedures would not be easy and might be disconcerting. Learning statistics requires that students apply new ideas and concepts, critically. Different cultural backgrounds tend to influence the interpretation of their previous experiences. Generally, when students reorganize and reinterpret the scenario, they adopt an approach where the student is regarded as the variable over time and over situation. Students should incorporate the new ideas into their perception, so that they could evaluate and begin to make choices about what they will, and will not do (Boud *et al.*, 2013). Given that the motivation may arise from a loss of confidence in, or disillusionment with their existing situation, students should implement new learning approaches, which they should repeat until they are confident enough (Biggs, 2011). Statistics learning has been observed to be adjustable, contingent on the content and environment.

Additionally, the participants made their own decisions, as a personal revelation of their strengths and progress of their abilities. The perceptions of the participants improved as the task progressed. As explained by Fullan (2007), students interpret new information according to the knowledge they already possess, in order to construct their own meaning, by linking the new idea to what they had already internalised. Unfortunately, some of students encountered conflicting, doubt and reluctance in their choices. Therefore, the assistance of peers and statistics monitors was desired. Participant 2 expressed the need of statistics assistance to learn, in a practical way, how to apply specific tasks with statistical procedures.

Regarding UWC, this current study established that the respondents had trouble with applying their ability, as their inspection of the data and the expected outcomes limited their flexibility to handle a right choice. As mentioned by Geary *et al.* (2008), highly anxious students had negative self-concepts, compared to others. In addition, the study revealed that the understanding of the data, and the expected outcomes enabled students to realize an appropriate choice. The participants were frustrated by their efforts to interpret real life problems; they expressed concern about using their experiences in research and statistics, effectively. Similar findings were achieved by Canon and Edmonson (2005), indicating challenged and disillusioned students should apply themselves to learn from their failures.

Regrettably, the failure of students to address the difficulties of selecting the correct approaches, tended to worsen this failure in statistics learning. The students were irritated and pessimistic, because their experiences were based on false intuitions, mistakes and misconceptions. Schunk and Pajares (2010) assert that postgraduate students from diverse cultural circumstances have diverse understandings and interpretations of data. Students have to investigate new ideas and concepts critically. Some of the participants assumed that choosing a statistical test was a task they could simply do without limitations; however, by progressing in the execution of the tasks, the students realized that there was more to it than they thought. Consequently, they became anxious and anxious about making mistakes. Similar findings were observed by Garfield *et al.* (2007), who claim that learning approaches are too passive for students, and should be implemented in their daily life, through continuous repetition until they became more confident. In this sense, Boud *et al.* (2013) argue that each student needs to determine his own concerns, explanations and skills. By taking their own decisions, the participants' uncovered hidden strengths in their abilities, for example, constructing personal senses, by linking original ideas to what they previously knew.

Conflicting choices encouraged some participants to ask for help peers and senior statisticians. Several reasons clarified the weaknesses of participants, namely, the lack of knowledge of theories, misunderstanding and confusing in the interpretation of the concepts, different areas of expertise, and unfamiliarity with the items. It was obvious that only pinpointing the keyword in an item was not sufficient to decide whether it was the right test to apply. Additional checking of the relevant assumptions, measurements of the variables, the data, sample size, understanding the research question, was vital to for better decisions, to draw accurate conclusions.

The area of expertise revealed a difference in the field of specialisation, which was an enormous challenge for the participants. Bandura (2012) acknowledges that a student is more effective when he refines the feedback, by interpreting the task, as well as adjusts internal goals and strategies. Many statistical ideas, conventions and rules posed challenges for the students to determine the correct choice, which provided the desired outcomes. These challenges included that the assumptions did not allow, did not satisfy the criteria for the test, and little evidence, which heavily influenced the rejection of some of the tests. Garfield *et al.* (2007) argue that the way students interpret data cause them to fail, in confusion.

One of the reasons may be the main interpretation of lecturers in higher education, namely that achievement and disappointment is the accountability of the student. Supervisors are likely to reason that the setting or background of student knowledge is not of excessive significance, and attribute achievement or disappointment to the appearances of the students. Students at UWC spend most of their time in one or two academic departments; therefore, it seems quite possible that the way students approach studying is influenced by the way the departments operate. Students are clearly aware that the departments differ in their attitudes toward them, in the same way that they observe that some supervisors are more effective at conducting supervision. All these reasons comprise the external effect of course organisation on student learning.

Many of the findings of this current research have immediate relevance to supervisors, who wish to improve their supervision, as well as for students who want to improve their method of studying. In addition, there are important implications for the enhancement of the efficiency of learning in the costly business of higher education. Currently, efficacious and weak students remain unchanged by the supervision and courses they encounter. Individual differences and the university environment interact subtly and continuously; therefore, a proper understanding of student learning needs to address both components. The focus is on the student's journey, as well as how it is influenced, for better or worse, by the environment in which it takes place.

In the next section, a briefly review of the Ordinal regression model and the use of Likert-type scales are presented, focussing on its weaknesses and strengths.

8.5. Limitations of ordinal regression and Likert-type scales

8.5.1. Strengths and limitations of ordinal regression in this current study

This study presents a brief explanation of the assets of the ordinal regression model. Various variables of learning statistics outcomes are on a Likert scale. Therefore, the ordinal regression model tends to perform diverse student learning outcomes.

Alike to the regression models, the ordinal regression model is designed firstly to find significant explanatory variables that impact the dependent variable; secondly to designate the trend of the connection between the descriptive variables and the ordinal outcome; and thirdly to complete categorisation for all levels of the SELS beliefs, and after assess the strength prediction of the regression model (Perepiczka *et al.*, 2011;
Logit, Cauchit, Probit, Negative log-log and Complementary log-log links enable to perform the consequence of the predictors on the dependent variable. The examination of matching shapes measure the rationality of the model supposition, and the model suitable measurements, for instance, the -2log likelihood ratio and pseudo R squares are considered as measures to monitor the aspirant models, and select the best model.

Lastly, the model adopts that the association among the independent attrbutes and the dependent variable is not taken in account the group. This supposition infers that the consistent regression coefficients in the relation meaning are equal for each group. Therefore, it is simple to concept and understand the ordinal regression model, which requires only one model assumption, and produces only one set of regression coefficients.

However, the application of the ordinal regression model reveals some limitations. For instance, the not applicable responses of independent attributes are considered as absent values and omitted from the investigation. A huge percentage of cells with absent data, tend to reduce the real sample magnitude for the model building, or an incorrect "chi-square test" for the suitable model. Bear in mind that the adjusted model's quality is generally reliant on the "chi-square test" outcome, which it is hang on the sample magnitude. Agresti (1996) acknowledges that a huge amount of cells with a zero value influence the suitability of the chi-squared goodness of fit statistics. This context limits the researchers' ability to measure the model's goodness of fit successfully. Furthermore, the logit, probit, cauchit, negative log-log and the complementary log-log link in the ordinal regression analysis cannot select a subgroup of important descriptive attributes, via unconscious model construction procedures, for example stepwise and spinal removal procedures in SPSS knowledge linguistic. Consequently, investigators are pleased to trust their individual perception and understandings, to choose a set of the important independent attributes in the model. Based on that, considerable time and vitality is engaged to emerging aspirant models, examination of the model conventions, and guaranteeing the adjusted model's quality.

8.5.2. Limitations of Likert-Type Scales on using and learning statistics

The main objective of learning statistics is to encourage a positive attitude toward statistics and its practices in students, as well as to develop their self-assurance. Therefore, the evaluation of the ability of actual instruments to investigate variations in students' with such problems is significant. In contrast, the students' aspects being measured, such as emotion, behaviour, social support ratings or SELS beliefs may be easily altered, and possible to oscillate, reliant on varying conditions and actions. Consequently, when interpreting the score changes, the expected stability of the constructs being measured, need to be considered, over time. However, studies using statistics emotion, behaviour and social support surveys regularly describe relationship information, or mean ratings' variations, but not absolute rating stages. Such information, while investigating the presence of associations among emotion cuts and the dependent variable, generate inadequate evidence about the type of that variable which is varying over time.

Statistical researchers compute absolute scores, by adding these scores to any other statistical facts, the inferences do not reflect the true facts evaluated. Described average rating variations, can be of incomplete amount, if they are not aggregate by information around tendencies of learning implication, for example the percentage of students whose ratings remained the unchanged, upgraded (additional constructive attitudes), or deteriorated (additional undesirable attitudes). Definitely, similar statistics are disguised once a particular statistic is planned on an entire illustration. Instruments such as the STARS, SATS, SELS and MSPSS produce ratings that are simply reportable, and are suitable to practice for an extensive explanation of the results of learning statistics. Such questionnaires cannot provide indicative evidence that can reveal to specific problems of anxiety for students; so, the present instruments of STARS, SATS, MSPSS and SELS have very inadequate competence to update about the improvement procedure, content of learning statistics via corrective and preventive measures.

Likert scales' responses expose little around the reasons for the respondents' answers, regarding emotion for instance, which may affect the students' attention, inspiration, and understanding, negatively. Therefore, it seems that the usefulness of Likert-type scales are incomplete, in terms of investigating whatever students are worried, their behaviours about statistics learning, as well as what categories of social support, or educational practices might be valuable for students. This important lack in the design of scales to measure students' emotions, social support and behaviours towards mathematics, lead researchers to consider semi-structured interviews, or request students to write pasts, of their current, or past, mathematical practises. The objective is to increase a nearer look on the previous educational experiences causing negative attitude on students' learning in numerical fields. In addition, some problems severely limit the interpretation of the achieved scores, at both individual, and group levels. These problems are, the tendency of not seeking descriptions from the themes for their responses, the practice of using total scores, and the distraction to the associations between attitudes towards statistics and other concepts, when understanding outcomes.

The significant improvement completed by instructors, in illustrating the changes between attitudes, beliefs and emotions, as well as between these and other connected concepts, such as social support, or self-efficacy (Pajares 1996; Schunk & Pajares, 2009), might produce an exceptional preliminary fact for statistics instructors, looking for to understand the issues that affect their students' achievement and learning. Development in understanding the role of some problems and their effects on statistics learning should be reinforced from two diverse, but connected guidelines. In one hand, the assessment of students' attitudes toward statistics should be improved, so that the sense, the reduction of anxiety, or negative approaches can be understood. Second, the collaboration among these undesirable approaches and students' emotions about themselves and field of study should be explored. Additionally, the expansion of evaluation instruments, to provide appropriate information of both conceptual and methodological, includes many challenges.

8.6. Synthesis and partial conclusion

In this chapter, the researcher presented a summary of the main procedures, a discussion of the findings for each university, a discussion of the results for the combined data of both universities, and the limitations of the Ordinal Regression Model and Likert-type scales. In the next chapter, an integration of the quantitative and the qualitative findings, for each university, as well as the combined data of both universities, is provided. Further, conclusions are presented, with recommendations, while attention is paid to the contributions and limitations of the study.

CHAPTER NINE

CONCLUSIONS, RECOMMENDATIONS, CONTRIBUTIONS AND LIMITATIONS OF THE STUDY

9.1. Introduction

Based on the UCT data, the UWC data, the combined data of these two institutions, the SELS beliefs, as well as how the statistical tests were examined, the researcher attempts to outline the overall outcomes of the research, its implications, in terms of existing findings, its meanings, according to the study context, and how it was investigated through variables such as individual characteristics, statistics anxiety, attitudes towards statistics and social support. Subsequently, an integration of the quantitative and qualitative findings for each context is presented. In addition, some recommendations are provided, through relevant policy interventions, concluding with a summary of the specific contributions of this current study to existing knowledge about statistics learning in South Africa, as well as the limitations of this study.

9.2. Conclusions

Statistics learning is one of the most important issues of statistics education today. International consciousness about the problem was manifested in the inclusion of statistics learning as one of the targets of the statistics education. Unfortunately, insufficient research has been conducted on the subject. Estimates of statistics learning levels are rare, controversial and sometimes contradictory. There is a great need to estimate the level, follow the structural change in the students' SELS beliefs, and scientific explanations of the immediate, and distant causes of failure in statistics learning. The situation is worse in developing countries, where the HES does not operate smoothly. The poor quality of existing data, as well as the lack of information about statistics learning, should not restrict researchers from providing answers to these problems. On the contrary, it is an encouragement, and an appeal for scientific investigation on the issue, to provide guidance, as well as make full use of the findings. It is acknowledged that achieving a superior standard of HES, is not for the short- or medium term, in developing countries, as South Africa; however, this solution remains the best, in order to provide adequate data regarding statistics learning. This is an additional argument, in favour of initiating research on the subject, without waiting for the availability of perfect data.

Given the disparities in knowledge about this issue, the researcher in this current research set out to examine the connection between the postgraduate students' SELS beliefs, STARS, SATS, and social support, as well as how to choose the right statistics test. Four objectives were assigned to the research. To reach the objectives of the study, two data sets were used, namely, quantitative and qualitative data for each institution, as well as the combined data from both universities (UCT and UWC). The following paragraphs focus on reviewing the main findings of each objective of the study. For the quantitative, descriptive analyses were undertaken at univariate and bivariate levels, and inferences drawn. At bivariate level, the effect of each predictor was tested individually, in relation to the dependent variable (SELS beliefs). The findings at bivariate levels could be biased, because of hidden factors; therefore, advanced analyses, based on the multivariate model, were conducted to achieve the objectives of the study. These results are highlighted and detailed in the findings, resulting from the analyses of the specific research questions of the research.

9.2.1. UCT

The results of the main objectives are summarized below, according to specific research questions:

- *What is the graduate student's experience level in statistics, and research methodology?*

  The overall descriptive results revealed that the graduate student's experience level in research methodology was average, and in statistics, it was good. The graduate students were well prepared in statistics, compared to research methodology.

- *What is the graduate student's statistics anxiety level?*

  In general, the graduate student's statistics anxiety level was low, except the "*Test and class"* anxiety component, which was moderate. The rest of the statistics anxiety components were low.

- *What is the graduate student's attitude toward statistics?*

Concerning attitudes toward statistics, the students achieved a moderate level. In fact, two of the six components, "*interest*" and "*effort*", indicated a high level, the rest of the components were moderate.

- *What is the graduate student's level of perceived social support?*

According to the *overall* perceived social support, the graduate students achieved a mildly agree level; however, the support from *"family members"* realised a strongly agree level.

- *What is the graduate student's self-efficacy level?*

In general, the current self-efficacy (self-efficacy to solve) for the graduate student's level indicated much confidence. However, one of the five components, vicarious, indicated very much confidence at the lower boundary. Concerning the expected self-efficacy (self-efficacy to learn), students realised very much confidence in all the components, given that the absolute difference between the current and expected self-efficacy, provided SELS, the ability to learn statistics (Schwartz & Martin, 2004). The difference was modest in the respondent's factual, conceptual and procedural understanding.

- *What are the effects of the individual's characteristics, experiences, emotion, behaviour and social support on the SELS beliefs at the UCT?*

Among the academic and demographic characteristics applied, no statistically significant difference was found in their means. The findings revealed that both experiences in statistics and in research methodology were statistically significant different in the means scores of the students. These experiences contributed positively to the graduate students' ability to learn statistics. More students with good in experiences tended to be more confident in SELS beliefs.

Regarding statistics anxiety, statements related to statistics (STASTATS) and the overall component of statistics anxiety (STARS) displayed a statistically significant difference in the means scores of the students. These variables negatively influenced their ability to learn statistics. For attitudes towards statistics components, only effort displayed a statistically significant difference in the means scores. The more effort the students exercised, the more they increased their ability to learn statistics. As for social support variables, no statistically significant results were found.

- *What are the factors that significantly predict SELS beliefs at the UCT?*

  The SELS beliefs were significantly related to four variables, namely, "*fear of statistics" monitors*, *postgraduate programmes*, *engineering department*, as well as *health & wellness department*. The academic variables revealed positive regression coefficients, indicating that students, who scored higher levels of satisfaction for these explanatory variables, were likely to achieve a higher level of SELS beliefs. Additionally, the students, who scored lower levels of fulfilment for these predicted variables, were likely to attain a lower level of SELS beliefs. Of these four predicted variables on the SELS beliefs, 75% or 3 variables were related to academic factors (*postgraduate programmes*, *engineering department*, as well as *health & wellness department*). Only 25 percent or 1 variable was related to emotion factors (fear of statistics teacher). In fact, students were encouraged to attend a minimum of consultations with statistics monitors, or peers. Unfortunately, many PhD/post-doctorate students did not ask for help, because they wanted to portray a standard of knowledge that they did not really possess, in order to preserve a fictitious personality. Similarly, further analysis revealed that the influence of belonging to a particular department, explained the importance of how experiences in research methodology and experiences in statistics acquired over years, enhanced the SELS beliefs levels of students. This best ordinal regression model at UCT appropriately completed 73% of prediction accuracy, for all three categories combined, which was quite high.

- *How do the students choose the appropriate statistical test?*

  Students, being aware of all the information concerning the one-on-one interviews, participated in selecting the appropriate statistical tests, on the various campuses of UCT. The responses, related to this research question, highlighted three sub-themes, namely, self-efficacy to choose a statistical test, perceived failures to choose the right test, and non-familiar statistical tests. The most common responses for self-efficacy focused on data issues, such as, understanding the concepts, knowledge of assumptions, the time since their last statistics class, and conflicting choices. The perceived failure to choose the right test, as presented in Chapter 5, mirrored the lack of information, confusion in the application of real life problems, as well as too little evidence. The non-familiar statistical tests indicated that the learning process failed to include the crucial stage of reorganization and reinterpretation, while the outcome was a reproduction of the scenario, which was unlikely to contain the central core of the author's information. Self-efficacy is associated with anxiety and helplessness. The students with low self-efficacy were frustrated about their personal development.

9.2.2. UWC

The answers of the main objectives are highlighted below, according to specific investigation queries:

- *What is the graduate student's experience level in statistics, and research methodology?*

  The graduate student's experience levels in research methodology and in statistics were average. They achieved an average level in *overall* experiences. The graduate students need to be more committed in their programmes.

- *What is the graduate student's statistics anxiety level?*

  Regarding statistics anxiety, the students scored low in five of the six components of STARS. In the "*Test and class"* anxiety component, they achieved a moderate level.

- *What is the graduate student's attitude toward statistics?*

  Referring to attitudes toward statistics, the students achieved a moderate positive attitude level in four of the six components of SATS. The other two, *interest* and *effort*, achieved a high positive attitude level.

- *What is the graduate student's level of perceived social support?*

  Concerning the overall perceived social support, the highest score of the students for family support was at the strongly agree level; while the rest of the social support components were at the mildly agree level.

- *What is the graduate student's self-efficacy level?*

  The current self-efficacy (self-efficacy to solve) of the graduate students displayed much confidence; however, one of its five components, emotional arousal, displayed fair confidence. The expected self-efficacy (self-efficacy to learn) for graduate students indicated much confidence in all its components. The absolute difference between the current and expected self-efficacy was the SELS beliefs. The alteration was dependent on the respondents' factual, conceptual and procedural understanding.

- *What are the effects of the individual's characteristics, emotion, behaviour and social support on the SELS beliefs at the UWC?*

  Regarding the academic and demographic characteristics, only *postgraduate programmes* and *marital status* influenced the SELS beliefs of graduate students. The impact of *postgraduate programmes* was positive, while *marital status* was negative. The further a student progressed in the postgraduate programme, the more s/he increased her/his confidence in SELS beliefs, while a student, who was married, tended to decrease in his/her SELS beliefs.

  Considering experiences, only *"experiences in research methodology"* had a statistically noteworthy change in the means ratings of the students. The "*experience in research methodology"* contributed positively to the SELS beliefs of postgraduate students.

  All the constituents of STARS indicated a negative impact on the ability of graduate students to learn statistics. Situations that were commonly associated with statistical anxiety (SITSTATS), statements related to statistics (STASTATS), and the overall component of statistics anxiety (STARS), exposed a statistically important modification in the means scores of the graduate students.
  Regarding the attitudes towards statistics components, none of these variables influenced the graduate students' ability to learn statistics, while for social support variables, no impact was found.

- *What are the factors that predict SELS beliefs, significantly, at the UWC?*

The SELS beliefs were significantly associated with three explanatory variables, namely, *experiences in statistics*, *ethnic groups* and *postgraduate programmes*. Two of the three predictors' variables (*ethnic groups* and *postgraduate programmes*) displayed positive regression coefficients, signifying that the students, who scored greater levels of approval in these attributes, were probably to have greater satisfaction with the SELS beliefs. Unfortunately, the *experience in statistics* tended to reduce the confidence of graduate students. This result revealed that the previous experience achieved in statistics, did not assist the graduate students to apply statistical knowledge in their postgraduate programmes. In addition, this confirmed the lack of a relationship with statisticians, or peers, for any help.

- *How do the students choose the appropriate statistical test?*

The above-mentioned objective was to describe the way the task of choosing a statistical test was carried out on UWC Bellville campus. The participants were well informed about the interview. Three sub-themes emerged from this research question, namely, self-efficacy to choose a statistical test, perceived failures to choose the right test, and unfamiliar with statistical tests. Regarding self-efficacy to choose a statistical test sub-theme, the most common responses highlighted some key features, such as, inspection of the data, understanding the problem, experiences in research and in statistics, as well as checking for different possibilities. For the perceived failure to choose the right test sub-theme, some causes and reasons were revealed as the lack of knowledge, confusion in interpretation, different area of expertise, and conflicting concepts in statistics. The unfamiliar with statistical tests sub-theme indicated a failure in the learning process because of the multiple backgrounds of the respondents, difficulty of separating the contributions of multiple approaches to teaching over time, from the students' learning process.

Self-efficacy was associated with anxiety and depression. Some of the graduate students with a low SELS beliefs, experienced confusion and frustration during the accomplishments of their tasks.

9.2.3. Combined data from both universities

The findings regarding the following research question are articulated below, *"What are the similarities and differences of the dependent variables across universities, and their impact on the SELS beliefs at both universities?"*

- **Comparison of variables across universities**

  Each of the following variables, *age groups*, *ethnic groups* and *gender*, were significantly associated with the *academic institution* variable. The proportion of graduate students in some *age groups* at UCT was knowingly dissimilar from the percentage of graduate students in the similar *age group* at UWC. The number of postgraduate students at UCT was higher among young students, while at UWC the number was higher among adult students. The differences across *ethnic groups* were quite substantial across universities. The presence of Black and Coloured students was more prominent at UWC than at UCT, while Indian and White students were more prominent at UCT than at UWC. Male students were more represented at UCT, while the numbers of female and male students were closer at UWC. The proportion of males decreased, while that of females increased, from UCT to UWC. Despite this decrease, postgraduate male students still constituted a higher proportion.

  The relationship between statements related to statistics (STASTATS) and the academic institution, as well as *overall* statistics anxiety and the *academic institution*, indicated significant differences. These differences could be observed in the performance of a task, as a student learns by doing, discovers new facts in group activity, or by sharing knowledge.

  Concerning behaviour variables, only *"effort"* was in association with the *academic institution* variable. However, the difference was observed in two groups (lowest and moderate). For social support, support from *"friends"* and the *overall* social support displayed differences in scores across universities. UCT students received more support from *"friends"*, compared to UWC students. The percentage of UWC students, who did not receive social support, was higher compared to UCT students. These influential factors reveal that students were experiencing challenging situations (making friends, transportation, and climate) without draining anxiety. The academic institution did not explain the variance observed in SELS beliefs.

- **Comparison effect of independent variables on the SELS beliefs at both universities**

  Regarding demographic and academic variables, only the postgraduate programmes variable displayed a substantial difference in the mean scores, between Master's and PhD/post-doctorate students. However, the difference in the means was relevant, which indicated a huge variance in SELS beliefs for both institutions.

  SITSTATS, STASTATS and STARS had a positive impact on the levels of the ability to learn statistics of graduate students at both universities. Therefore, students with low anxiety were slightly more advanced in learning statistics, compared to those with moderate or high anxiety, respectively, for SITSTATS, STASTATS and STARS.

  Regarding experience, only experiences in research methodology positively influenced the levels of SELS beliefs. Students with good experiences in research methodology were more advanced in the ability to learn statistics, compared to students with average experiences in research methodology.

  For social support, both support from "*significant others*" and support from "*friends*" had statistically major alterations in the means ratings of the graduate students. These supports contributed positively to the SELS beliefs. Attitude toward statistics components did not significantly influence the SELS beliefs.

9.2.4. Summary of the qualitative findings from UCT and UWC

Students of both universities were well-informed about the interview session for the choosing of the correct statistical tests on different UCT and UWC campuses. The responses of the participants were grouped into the following three sub-themes: self-efficacy to choose a statistical test, perceived failures to choose the right test, and non-familiar statistical tests. The shared responses for the sub-theme, self-efficacy to choose a statistical test, at both institutions, included: inspection of the data; inspection of concepts; understanding of the items; knowledge of assumptions; experiences in statistics; conflicting choices; contradictions; doubt; checking different possibilities; and confident about the decision made. Regarding the sub-theme, perceived failures to choose the right test, some major causes were revealed, namely: lack of information; lack of knowledge; confusion in application to, and interpretation of, real life problems; different areas of expertise; conflicting concepts in statistics; different fields of expertise, referring to peers; and less evidence. For the sub-theme, non-familiar with statistical tests, several reasons were observed for the failure in the learning process, namely: multiple backgrounds of the respondents; and difficulty of separating the contributions of multiple approaches of teaching over time, from the students' learning process. Therefore, students with low self-efficacy were frustrated, and confused about their performance. Consequently, the choice of the right statistics test was related to anxiety, depression and helplessness.

9.3. Integrating the qualitative and quantitative results

A synthesis of the qualitative and quantitative outcomes shown that the answers were complementary for the three sets of data, namely, UCT, UWC and the combined data. Both the qualitative and the quantitative results revealed that contributing factors and various sources of errors were the major barriers restricting statistics learning in the academic institutions.

9.3.1. UCT

For UCT, both the qualitative and quantitative findings revealed, were in harmony. However, with the choice of a relevant statistical test, the qualitative results were more meaningful than the quantitative results, as the semi-structured interviews allowed the participants to express their views, uninhibited. Several students were so confused to choose the relevant statistical test that they expressed concern about their failure. In addition, fear of statistics monitors, engineering department, health & wellness department and postgraduate programmes were the main obstacles restricting the level of SELS beliefs at UCT. These barriers represented the main predictors of SELS beliefs. Considering the practical knowledge to choose a statistical test, the respondents encountered many difficulties, including, the inspection of keywords and objectives, as well as knowledge of assumptions. The lack of information about the items, as well as the lack of knowledge about its application to apply real world problems, proved extremely useful in highlighting the students' confidence about the decision made (choice). Non-familiarity with the items and less evidence could be the elucidations observed, during the failures to select the test.

Regarding the impact of the differences in mean scores of SELS beliefs between groups, the association between SELS beliefs and the factors were investigated, using an "independent-samples t-test" and a "One-way ANOVA test", and the results have been complementary again. The study suggested the indicators to identify the mean significant difference in SELS belief scores between groups (experiences in research methodology, experiences in statistics, STASTATS, STARS and effort) and the criteria predicted from the ordinal regression model, using the logit link function. This section illustrates that five of the indicators, suggesting their impact on the SELS beliefs, and the predictors arising from the ordinal regression model, using logit link function, were similar. The similarities between the indicators that emerged from the impact, and the predictors from the ordinal regression model, reflect a high degree of credibility in the research design. Although, the respondents, who were inclined to have experiences in research methodology and statistics were from the Engineering and Health & Wellness departments, fear of statistics monitors was one of the components of STASTATS and STARS. Mixed methods presents the assets and weaknesses of a search query, as mentioned by Creswell (2013; 2014); therefore, the strengths of the qualitative and quantitative methods could combine to reinforce a better understanding of the research problem (to develop a practical approach for post-graduate students to apply statistical procedures, effectively, in an academic environment).

The predictor factors of SELS beliefs, as well as the quality of the choices of statistical procedures factors, improved the credibility of the findings, while also signifying that the research design, adopted for the study, was both valid and reliable. This complementarity of the research findings also lent credibility to the research strategy implemented. However, it is imperative to stress the need for these criteria to be updated, or revised periodically, to ensure that they reflect the realities of the SELS beliefs, based on change and social dynamics, because students are active, and constantly changing.

9.3.2. UWC

Similarly, for UWC, a combination of the qualitative and quantitative results proved to be complementary. According to the quantitative results, the following factors were the major barriers that restricted the level of SELS beliefs in the UWC model of ordinal regression, using the Cauchit link function. They were, belief factors (the "*worth of statistics"*, "*fear of asking for help"*, and "*fear of statistics" monitors*); socio-demographic factors (*ethnic group*, and *marital status*); academic factors (*type of study*, and "*attitudes towards the course"*); other factors ("*affect" and "cognitive competence"*); as well as social support factors (support from "*significant others"*). Regarding the quality of SELS beliefs, the qualitative results were more revealing than the quantitative results. The 34 topics, related to statistics, applied through their postgraduate research in sciences, social and behavioural sciences, allowed the participants to express their satisfaction with the quality of their choices of a statistical test. In addition, the qualitative results highlighted that their experiences (in research methodology and statistics) were useful determinants of SELS beliefs, as well as significant to the quality of choices of statistical procedures. Three sub-themes arose from the qualitative study, namely, major concerns about the choice of a correct statistical test, practical knowledge to choose a relevant test, and confidence about the decision made.

Some of the participants were limited in their flexibility to choose the right statistical test, because of relatively negative self-concepts that underestimated the quality of their ability, while other students expressed concern about their use of statistical procedures, even when they were offered free assistance. In the terms of the practical knowledge to choose a statistical test, the participants experienced a succession of problems that they had to solve. Concerning confidence about the decision made, the participants initially underestimated the level of proficiency that the type of task required. The lack of information, lack of knowledge, difficulty with applying to real life problems, non-familiarity with the items, misunderstanding of the items, confusion in the interpretation of the concepts, conflicting concepts in statistics, different areas of expertise, the degree of familiarity with a specific test, inability to apply prior experiences, less evidence, did not satisfy criteria for the test (assumptions do not allow), as well as not referring to peer students and statistics monitors, might be the reasons for the difficulty observed during the practical task. The challenges arose because of the influence of the multiple backgrounds of the participants, as well as the difficulty of separating the contributions of these multiple approaches of teaching over time, from the students' learning process.

The fact that the qualitative and the quantitative results largely complemented each other with respect to these major predictor factors of SELS beliefs, and the quality of the choices of statistics test factors, enhanced the credibility of the findings, while also signifying that the research design adopted for the study was both valid and reliable. This complementarity of the research findings also gave credence to the research strategy adopted. Creswell (2013) and Morgan (1998) assert that a mixed methods research design make available a wider thoughtful of the investigation query, compared to either the qualitative or quantitative approach could, in isolation. Regarding the impact of the predictors of SELS beliefs, the purpose of this question was to investigate the means difference of SELS beliefs among groups. This involved the investigation of the association between SELS beliefs and the possible predictors of SELS beliefs. Ultimately, the results were again complementary. The findings of this study revealed a significant means difference of SELS beliefs scores between groups, for postgraduate programmes, marital status, experience in research methodology, SITSTATS, STASTATS and STARS.

The findings further suggested that the impact on SELS beliefs of four of the indicators, namely, *marital status, "worth of statistics", "asking for help"*, as well as "*fear of statistics"* monitors, and the predictors arising from the ordinal regression model, using the cauchit link function, were similar. These similarities reflect a high degree of credibility in the research design. The main reason for selecting a mixed methods research design was that, as both qualitative and measurable approaches had assets and faintness, the strengths could be combined to enable a more complete appreciative of the examination issues (Creswell, 2014). The impact of associations regarding the issue of marital status, indicated that single students deserved exemptions. Another very revealing descriptor was that 50% of the students had low anxiety, against 9% with high anxiety. This aspect was revealed in this current study, but was not evident in the literature; therefore, it is an issue that merits further investigation. Regarding STASTATS, 71.8% of students scored low anxiety, while 7.7% scored high anxiety.

The “independent sample t-test” showed that students with STASTATS were more prospective to score low anxiety about SELS beliefs.

When integrating the findings of the qualitative and the ordinal regression, using cauchit link function model, the final proposed model predicted significant SELS beliefs, which contained the following variables, namely, “*ethnic group”*, “*marital status”*, “*type of study”*, “*ask for help”*, “*worth of statistics”*, “*fear of statistic*s” monitors, “*affect”* factor, *cognitive competence* and support from *significant others*.

In particular, these findings are verifiable at the university level, and because society is dynamic and in constant flux, it is essential that these be updated, or revised periodically, so as to ensure that they reflect the realities of SELS beliefs, based on societal changes and dynamics.

9.3.3. Both UCT and UWC

The goal of this current research was to make available a voice for students, and generate a more powerful voice for statistics learning challenges at both universities. The quantitative data provided the generalised patterns of statistics learning (frustration, confusion, misunderstanding of concepts and lack of knowledge), while the qualitative information provided the individual narratives of students. The intention of this current study was to first collect survey data, and then interview students to understand their statistics learning patterns in more depth (an explanatory sequential design). The significance of the qualitative and quantitative components was equal, with the objective that both contributed to the understanding the research problem. The mixing occurred through connecting the results of the quantitative survey, and exploring these, in-depth, in the qualitative phase. Because self-efficacy to learn theory was discussed throughout the study, with a focus on equality, and giving a voice to students, the study employed an explicit theoretical self-efficacy lens.

The diversity of results seems to be compatible with relatively strong, moderate and weak performances, in particular contexts. This may be, partly, because there are a variety of methods to accomplish, basically, the same thing, and partly, because the ability to learn statistics is a larger factor, in some contexts, than in others.

Based on the description of the codes, or comments of the participants, it is obvious that changes in the external and internal environments of higher education have influenced the way in which the learning statistics dimension has been manifested. Although each study could stand alone on its own merits, the principal purpose of this project has been to map out what is similar, and different about both universities. The above analyses have laid out some of the shared understandings about the learning statistics changes, application of statistical procedures, learning processes and the institutions involved, which have broadly guided the work.

9.4. Policy recommendations

This current study has provided important outcomes that could be useful to researchers in the domain. In addition, it could involve to an improved orientation of schemes and programmes related to statistics knowledge. Therefore, certain recommendations could be made to government authorities, planners and policymakers, some of which already exist in programmes initiated to address statistics education in South Africa. However, most of these existing recommendations do not have a scientific, or empirical, basis, using specific information from South Africa, as certain information comes from old scientific research that reflects the past realities of the country. The socioeconomic and cultural contexts of the university (country) transform rapidly; therefore, the need for updated information does not suffer contradiction, even when they only confirm future results. Finally, this study has the merit of highlighting the particularities of UCT, UWC, and universities in the Western Cape region of the country, regarding the issue of statistics learning.

9.4.1. A benchmark as a guide for future research

There is no chance for good governance, without good knowledge of past and current situations, as well as a good vision and planning for the future. Policy making is one of the key methods of safeguarding decent planning, which is the minimum requirement of a sustainable development. Unfortunately, very few statistics education researches focus on this area. The United Nations agencies, and other international agencies, are not enough to cover the demands of policy makers, planners and other statistics users, regarding the wide range of student issues, such as statistics learning. Therefore, this study was initiated to provide a benchmark. One of the objectives was to serve as guide for future research.

9.4.2. Consideration of a multi-disciplinary character of statistics learning

This recommendation aims more at collaboration between different development sectors' programmes and projects. In fact, findings from this current research reveal that the risk of SELS beliefs has a *gender* component, as well as *marital status*, *ethnic groups*, *emotion*, *behaviour*, and *social support* components. Actors engaged in these domains should participate in decision-making on statistics learning programmes, as well as incorporate the issue as target of their programmes and projects. In the researcher's opinion, it is an effective and efficient solution to record a rapid decrease in the trend of SELS beliefs.

9.4.3. Knowledge transfer improvement in statistics monitors, supervisors and peers

The findings of this current research recommend an improvement of knowledge transfer from the statistics monitors to students. Encouraging easy collaboration demands the availability of statistics monitors, and the appropriate communication between them and the students; however, it also involves the building of more connections of reference, as well as equipping peers in their capacity for interventions.

The findings further indicate the need to pay more attention to statistics monitors, and, in particular, the conditions of the transfer. Knowledge transfers in statistics are only efficient under the requirement of context, during the transfer of knowledge. Additionally, improving actions against failure in statistics learning is crucial, when students are in critical situation, just after the judgment has been made, and lack of proper knowledge established. This recommendation will lead to satisfactory results, if emphasis is placed to increasing the number of meetings (as well as statistics monitors, who are well trained in statistics issues), and making offices available for consultations in most departments. The latter recommendations aim at bringing consultations closer to students, reducing distances, and improving conditions of good communication during knowledge transfer.

9.4.4. Strengthen learning programmes with an important statistics education aspect

This recommendation highlights the importance of statistics learning, as less attention is being given to statistics learning of postgraduate students. This is evidenced by the availability of information on statistics learning, and the lack of information about student learning. The findings revealed that the "*fear of statistics"* monitors was among the core risk factors of statistics learning at UCT, as well as UWC. With the high level of *ethnic group*, *type of study*, *marital status*, "*worth of statistics"*, "*cognitive competence"*, support from "*significant others"*, "*affect"*, and "*ask for help"* at UWC, the level of SELS beliefs was reinforced by occurrences of failure. All the dimensions of statistics learning, such as knowledge of statistics, learning selection skills, as well as social support that are exposed to failures, need to be re-addressed at university level.

9.4.5. Promote student empowerment for self-regulated learning

The results of this current study highlighted many aspects of statistics issues in the country. The impact of statistics learning on employment and poverty, in general, highlights the importance of empowering students, regarding their predictors of failure in statistics learning. Therefore, this recommendation is made to reinforce endeavours for the financial and psychological empowerment of students. In the context of this current study, the students' choices of *academic institution* and *postgraduate programmes*, their "*fear of statistics"* monitors, and social support, play a significant role, in terms of their self-regulated in statistics learning and their employment status, financial means and decision-making power.

9.4.6. Particular attention to young postgraduate students

This recommendation responds to the high risk of failure in statistics learning by young post-graduate students. The decreased rate of post-graduate students in the 20-25 and 26-30 age groups may be the consequence of learning method failures. Although some may consider learning selection skills unimportant to a statistics course, students may be able to choose the appropriate test from a book, but there are no guidelines for selecting a suitable statistical test. A special programme is required to train, or assist young postgraduate students in learning selection skills issues and statistics learning risk factors. Young graduate students should be involved with this programme, and subject to available funds, the programme could be extended to all postgraduate students. Such a programme could even involve all the students at the University.

9.4.7. Consideration of specific population groups with important impact

This recommendation aims at the inclusion of, or at paying particular attention to some sub-populations, because of the important impact they have on statistics learning levels. The results of the analyses revealed that the female population should be encouraged, or granted more consideration, in programmes and projects related to statistics learning, as at UCT for instance, female students represented only 23.2% of the student body, compared to males. This situation may be due to lack of understanding regarding the importance of postgraduate studies, or cultural constraints, in terms of knowledge in mathematics, or female students encountered more opposition, when seeking better employment opportunities. However, this recommendation highlights female students as a target population for programmes and projects involving statistics learning.

Actions against failure in statistics learning should target females from their childhood. In addition, programmes about failure in statistics learning should be translated into ethnic languages, and awareness campaigns conducted in these ethnic groups' languages, to ensure that the message reaches entire population groups. Television and radio programmes should also be developed in these ethnic groups' languages.

9.4.8. Consideration of a university approach to knowledge failure in statistics learning

This recommendation supports the consideration of the university specificities in the design of programmes and projects related to failure in statistics learning. The university approach suggests that each university should have its particular answer to the statistics-learning problem, and a committee set up for its monitoring and implementation. This recommendation aims to bridge the huge gap between universities, in terms of levels and risks of statistics failure. Budget allowances should also follow a scientific repartition, due to the emergency needs at some universities. Preference, or deep consideration, should be accorded to universities that appear to be most at risk of failure in the country. This study recommends an in-depth investigation into the wide gap at universities in South Africa, in terms of failure in statistics learning, and calls for rapid and energetic action, to reduce the level of knowledge failure in statistics.

9.4.9. Need for a specific national survey on statistics learning

This recommendation proposes a regular survey on statistics learning, covering the entire country with university representativeness. The lack of a national survey on statistics learning is a crucial problem, as censuses cannot incorporate enough questions to cover the education issue. A university survey, incorporating both distant and immediate risk factors of statistics learning, would provide better information, and allow better understanding of the problem, in all respects. Many actions are taken against failure in statistics learning, but there is no deep research, covering the entire country with complete data on statistics learning in South Africa. Such data is imperative to refine existent knowledge on the issue. A regular execution of the survey would be very useful for the monitoring and implementation of programmes and projects. The incorporation of statistics education into existent surveys, or censuses, could not replace the need for a full survey, well designed to capture and comprehend the issue. Further research studies need to be conducted into the improvement, or elaboration of a more precise methodology of statistics learning estimates, using full survey data.

9.5. Contributions and limitations of the study

In this section, a summary of the specific contributions of this current study to existing knowledge about statistics learning in South Africa is presented. Analyses initiated in this study are based on the most recent three data sets in UCT, UWC and combined data of both universities. In addition, the combination of these three data sets is the main strength of this research, in the sense that it facilitated the knowledge of statistics learning at UCT, UWC, and the combined level at both universities.

The results of this current study contribute to existing knowledge, methodologically and theoretically, as well as in terms of the development of policies and practices. Methodologically, the procedure adopted for identifying the best ordinal regression model, is original and innovative, and, as such, may be applied in contexts other than UCT, UWC, and the combined data of both universities. Therefore, this procedure contributes to the existing methodologies that aim to identify the best model of SELS beliefs. Theoretically, the extensive review of the concepts of STARS, SATS, MSPSS, and prior experiences, and the way in which they relate to SELS beliefs, contributes to existing and on-going discourses on how to provide equitable interventions to the less advantaged in society, in a socially acceptable manner. In particular, the institutional relations of the power framework adopted for the purposes of this current study, have illuminated the understanding of the dimensions of learning selection skills issues. In this regard, the analytical framework is equally relevant to each university, or for combined data, in seeking to examine the best model of SELS beliefs and learning selection skills issues. In terms of an academic contribution, researchers and students would observe the effective application of the theories of SELS beliefs. Finally, this current study successfully sheds light on the factors that constrain the improvement of SELS beliefs. The constrains underlined in this current study are extremely relevant to both the development of policies and practices, because they highlight specific issues that need to be addressed, in terms of SELS beliefs and learning selection skills issues. The researcher is of the opinion that careful consideration of the above recommendations by policy makers would decrease students' risk of failure in statistics learning at universities.

Finally, this current research integrated a university level of understanding, regarding the issue, and proposed a regional (Western Cape) solution to the problem in South Africa. This is one of the most important contributions, in addition to the originality of some of the results. According to the researcher, this information contributes towards improving the knowledge about SELS beliefs and learning selection skills issues. The use of this information should provide a better orientation of related projects and programmes, specifically with a regional level of understanding.

However, based on the time consuming and restrictions of obtaining relevant data from other universities, the lack of more data from a broad viewpoint appears to be one of the limitations of this current study. Time data is required, to fit the time series model better, for the incorporation of both distant and immediate predictors of SELS beliefs in one model, and in the learning selection skills. In addition, only regional survey data provided information, allowing for only regional estimates of SELS beliefs. Finally, more qualitative data is required to compare the outcomes of the quantitative examination, with the opinions of experts, authorities, as well as the male and female students. This qualitative survey could have facilitated more clarification of the quantitative findings, as well as the experts' opinions about the inputs of the projection model.

Although student performance is determined, in terms of degree results, how the student learns has not been assessed, at least not until very recently. How could this lack of interest be explained? For students to discover that learning can be more than memorisation, even meaningful, it is crucial to include the identification of different strategies of learning. This current research examines different conceptions of subject matter, as well as the differences in how students approach learning tasks. In addition, it explores how these differences arise and how they are related to the level of understanding reached.

The results of attempts to predict SELS beliefs by this method (quantitative) cannot be considered clear. The associations between SELS beliefs and student characteristics (*age, gender, ethnic groups, marital status, type of study, student status, postgraduate programmes,* previous experiences, STARS, SATS and social support ratings) are often low. It seems as if something happens during the period of the student's university experience, which research has not been examined. However, this does not imply that individual differences between students should be ignored. Students enter higher education with different interests, expectations, motivations and personalities. It would be surprising if the ways in which they study, were not related to their individual preferences. However, it is quite another issue to argue that there is one best combination of individual characteristics, which leads to success, or alternatively, failure.

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APPENDICES

Appendix 1: Additional tables

Distribution SELS

Options	frequency	%
A Little confidence	68	45
Fair amount confidence	69	45.7
Much confidence	14	9.3
Total	**151**	**100**

Post Hoc Tests

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
SIG. O.	Tukey HSD	Low	Moderate	.394	.290	.365	-.292	1.079
			High	.426	.253	.213	-.172	1.024
		Moderate	Low	-.394	.290	.365	-1.079	0.292
			High	.032	.177	.982	-.386	0.450
		High	Low	-.426	.253	.213	-1.024	0.172
			Moderate	-.032	.177	.982	-.450	0.386
Family	Tukey HSD	Low	Moderate	.474	.324	.312	-.294	1.242
			High	.381	.293	.397	-.313	1.075
		Moderate	Low	-.474	.324	.312	-1.242	0.294
			High	-.093	.174	.856	-.504	0.319
		High	Low	-.381	.293	.397	-1.075	0.313
			Moderate	.093	.174	.856	-.319	0.504
Friends	Tukey HSD	Low	Moderate	-.052	.349	.988	-.877	0.774
			High	.262	.311	.676	-.473	0.997
		Moderate	Low	.052	.349	.988	-.774	0.877
			High	.314	.189	.223	-.133	0.761
		High	Low	-.262	.311	.676	-.997	0.473
			Moderate	-.314	.189	.223	-.761	0.133
Social sup	Tukey HSD	Low	Moderate	.421	.368	.487	-.449	1.292
			High	.479	.335	.329	-.315	1.273
		Moderate	Low	-.421	.368	.487	-1.292	0.449
			High	.058	.182	.947	-.374	0.489
		High	Low	-.479	.335	.329	-1.273	0.315
			Moderate	-.058	.182	.947	-.489	0.374

Distribution of student's STARS

	Low anxiety	Moderate anxiety	High anxiety	Total	Mean	SD
	N (%)	N (%)	N (%)	N (%)		
SITSTATS	78 (50)	64 (41)	14 (9)	156(100)	1.59	.651
STASTATS	112 (71.8)	32 (20.5)	12 (7.7)	156(100)	1.36	.622
STARS	99 (63.5)	49 (31.4)	8 (5.1)	156(100)	1.42	.590

Distribution SELS

SELS	frequency	%
A little confidence	79	50.6
Fair amount confidence	55	35.3
Much confidence	22	14.1
Total	**156**	**100**

Multiple comparisons

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Affect	Tukey HSD	Low	Moderate	-.107	.156	.772	-.477	.263
			High	-.140	.175	.703	-.554	.274
		Moderate	Low	.107	.156	.772	-.263	.477
			High	-.033	.189	.984	-.480	.415
		High	Low	.140	.175	.703	-.274	.554
			Moderate	.033	.189	.984	-.415	.480
Cog comp.	Tukey HSD	Low	Moderate	-.333	.156	.085	-.701	.035
			High	-.201	.175	.484	-.614	.212
		Moderate	Low	.333	.156	.085	-.035	.701
			High	.132	.193	.773	-.324	.588
		High	Low	.201	.175	.484	-.212	.614
			Moderate	-.132	.193	.773	-.588	.324
Value	Tukey HSD	Low	Moderate	-.088	.163	.853	-.473	.298
			High	-.116	.203	.836	-.597	.365
		Moderate	Low	.088	.163	.853	-.298	.473
			High	-.028	.231	.992	-.574	.518
		High	Low	.116	.203	.836	-.365	.597
			Moderate	.028	.231	.992	-.518	.574

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Difficulty	Tukey HSD	Low	Moderate	.019	.170	.993	-.383	.420
			High	.065	.185	.935	-.374	.504
		Moderate	Low	-.019	.170	.993	-.420	.383
			High	.046	.160	.955	-.332	.424
		High	Low	-.065	.185	.935	-.504	.374
			Moderate	-.046	.160	.955	-.424	.332
Interest	Tukey HSD	Low	Moderate	-.153	.247	.809	-.737	.431
			High	-.139	.197	.762	-.606	.328
		Moderate	Low	.153	.247	.809	-.431	.737
			High	.014	.187	.997	-.429	.457
		High	Low	.139	.197	.762	-.328	.606
			Moderate	-.014	.187	.997	-.457	.429
Effort	Tukey HSD	Low	Moderate	-.167	.244	.773	-.743	.410
			High	.016	.179	.996	-.408	.439
		Moderate	Low	.167	.244	.773	-.410	.743
			High	.182	.201	.638	-.294	.659
		High	Low	-.016	.179	.996	-.439	.408
			Moderate	-.182	.201	.638	-.659	.294
SATS	Tukey HSD	Low	Moderate	-.049	.178	.959	-.471	.373
			High	-.119	.208	.835	-.610	.373
		Moderate	Low	.049	.178	.959	-.373	.471
			High	-.070	.165	.907	-.461	.322
		High	Low	.119	.208	.835	-.373	.610
			Moderate	.070	.165	.907	-.322	.461

Multiple comparisons

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
SIG. O.	Tukey HSD	Low	Moderate	.163	.249	.790	-.426	.752
			High	-.009	.205	.999	-.495	.476
		Moderate	Low	-.163	.249	.790	-.752	.426
			High	-.172	.181	.609	-.602	.257
		High	Low	.009	.205	.999	-.476	.495
			Moderate	.172	.181	.609	-.257	.602

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Family members	Tukey HSD	Low	Moderate	.081	.289	.957	-.603	.765
			High	.016	.239	.997	-.549	.581
		Moderate	Low	-.081	.289	.957	-.765	.603
			High	-.065	.196	.941	-.529	.399
		High	Low	-.016	.239	.997	-.581	.549
			Moderate	.065	.196	.941	-.399	.529
Friends	Tukey HSD	Low	Moderate	-.302	.255	.464	-.907	.302
			High	-.034	.213	.986	-.539	.471
		Moderate	Low	.302	.255	.464	-.302	.907
			High	.268	.180	.298	-.158	.695
		High	Low	.034	.213	.986	-.471	.539
			Moderate	-.268	.180	.298	-.695	.158
Social support	Tukey HSD	Low	Moderate	.284	.289	.588	-.399	.968
			High	.033	.218	.987	-.483	.549
		Moderate	Low	-.284	.289	.588	-.968	.399
			High	-.251	.218	.484	-.767	.265
		High	Low	-.033	.218	.987	-.549	.483
			Moderate	.251	.218	.484	-.265	.767

Distribution of student's STARS

	Low anxiety	Moderate anxiety	High anxiety	Total	Mean	SD
	N (%)	N (%)	N (%)	N (%)		
SITSTATS	173 (56.4)	112 (53.5)	22 (7.2)	307(100)	1.51	.628
STASTATS	245 (79.8)	49 (16.0)	13 (4.2)	307(100)	1.24	.520
STARS	222 (72.3)	75 (24.4)	10 (3.3)	307(100)	1.31	.529

Distribution SELS both

Label	n	%
A little confidence	147	47.9
Fair amount confidence	124	40.4
Much confidence	36	11.7
Total	**307**	**100**

Post Hoc Tests

				Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Affect	Tukey HSD	Low	Moderate	.038	.107	.932	-.214	.290
			High	-.152	.123	.431	-.442	.137
		Moderate	Low	-.038	.107	.932	-.290	.214
			High	-.191	.131	.313	-.498	.117
		High	Low	.152	.123	.431	-.137	.442
			Moderate	.191	.131	.313	-.117	.498
Cog comp.	Tukey HSD	Low	Moderate	.033	.105	.949	-.216	.281
			High	-.021	.129	.986	-.324	.282
		Moderate	Low	-.033	.105	.949	-.281	.216
			High	-.054	.135	.918	-.372	.265
		High	Low	.021	.129	.986	-.282	.324
			Moderate	.054	.135	.918	-.265	.372
Value	Tukey HSD	Low	Moderate	.028	.110	.966	-.232	.288
			High	-.203	.152	.378	-.562	.156
		Moderate	Low	-.028	.110	.966	-.288	.232
			High	-.231	.169	.360	-.629	.167
		High	Low	.203	.152	.378	-.156	.562
			Moderate	.231	.169	.360	-.167	.629
Difficulty	Tukey HSD	Low	Moderate	.176	.120	.309	-.107	.460
			High	.095	.129	.742	-.210	.400
		Moderate	Low	-.176	.120	.309	-.460	.107
			High	-.081	.108	.736	-.336	.174
		High	Low	-.095	.129	.742	-.400	.210
			Moderate	.081	.108	.736	-.174	.336
Interest	Tukey HSD	Low	Moderate	.135	.189	.758	-.312	.581
			High	.087	.153	.838	-.274	.447
		Moderate	Low	-.135	.189	.758	-.581	.312
			High	-.048	.135	.933	-.367	.271
		High	Low	-.087	.153	.838	-.447	.274
			Moderate	.048	.135	.933	-.271	.367
Effort	Tukey HSD	Low	Moderate	-.030	.171	.983	-.434	.373
			High	.076	.139	.849	-.251	.403
		Moderate	Low	.030	.171	.983	-.373	.434
			High	.106	.128	.686	-.196	.408
		High	Low	-.076	.139	.849	-.403	.251
			Moderate	-.106	.128	.686	-.408	.196
SATS	Tukey HSD	Low	Moderate	.062	.132	.886	-.248	.372
			High	-.143	.150	.608	-.497	.211
		Moderate	Low	-.062	.132	.886	-.372	.248
			High	-.205	.112	.163	-.469	.060
		High	Low	.143	.150	.608	-.211	.497
			Moderate	.205	.112	.163	-.060	.469

Appendix 2: Application to do research Form DSA 100 – UCT

	RESEARCH ACCESS TO STUDENTS	DSA 100

NOTES

1. This form must be **FULLY** completed by all applicants that want to access UCT students for the purpose of research.
2. Return the fully completed **(a) DSA 100 application form by email, in the same word format, together with your: (b) research proposal inclusive of your survey, (c) copy of your ethics approval letter / proof (d) informed consent letter** to: Moonira.Khan@uct.ac.za. You application will be attended to by the Executive Director, Department of Student Affairs (DSA), UCT.
3. The turnaround time for a reply is **approximately 10 working days.**
4. NB: It is the responsibility of the researcher/s to apply for and to obtain **ethics approval <u>and</u> to comply with amendments that may be requested;** as well as **to obtain** approval to access UCT staff and/or UCT students, from the following, at UCT, respectively: (a) **Ethics:** Chairperson, Faculty Research Ethics Committee' (FREC) for ethics approval, (b) **Staff access:** Executive Director: HR for approval to access UCT staff, and (c) **Student access:** Executive Director: Student Affairs for approval to access UCT students.
5. **Note:** UCT Senate Research Protocols requires compliance to the above, **even if prior approval has been obtained from any other institution/agency. UCT's research protocol requirements applies to all persons, institutions and agencies from UCT and external to UCT who want to conduct research on human subjects for academic, marketing or service related reasons at UCT.**
6. **Should approval be granted to access UCT students for this research study, such approval is effective for a period of one year from the date of approval (as stated in Section D of this form), and the approval expires automatically on the last day.**
7. **The approving authority reserves the right to revoke an approval based on reasonable grounds and/or new information.**

SECTION A: RESEARCH APPLICANT/S DETAILS

Position	Staff / Student No	Title and Name	Contact Details (Email / Cell / land line)
A.1 Student Number	3008010	Ms Germaine Kamleu	germainekam@gmail.com / 078 123 9860
A.2 Academic / PASS Staff No.			
A.3 Visitor/ Researcher ID No.			
A.4 University at which a student or employee		Address if not UCT: University of the Western cape, Robert sobukwe road, Bellville 7535.	
A.5 Faculty/ Department/School	Faculty of Natural Science / Mathematics and Applied Mathematics Department		
A.6 APPLICANTS DETAILS If different from above	Title and Name	Tel.	Email

SECTION B: RESEARCHER/S SUPERVISOR/S DETAILS

Position	Title and Name	Tel.	Email
B.1 Supervisor	Prof Lorna Holtman	021 959 2451/3920	lholtman@uwc.ac.za
B.2 Co-Supervisor/s	Dr Bingwen Yan	+27 (0)21 460 3911	yanb@cput.ac.za

SECTION B: RESEARCHER/S SUPERVISOR/S DETAILS

Position	Title and Name	Tel.	Email
B.1 Supervisor			

SECTION C: APPLICANT'S RESEARCH STUDY FIELD AND APPROVAL STATUS

C.1 Degree – if applicable	PhD
C.2 Research Project Title	An analytical model for assessing the knowledge of statistical procedures amongst postgraduate students in a Higher Educational Environment
C.3 Research Proposal	Attached: Yes ■ No ☐
C.4 Target population	Master, PhD and post-doctorate students
C.5 Lead Researcher details	If different from applicant:
C6. Will use research assistant/s	Yes ☐ No ■ If yes- provide a list of names, contact details and ID no.
C.7 Research Methodology and Informed consent:	Research methodology: *Survey* Informed consent: *Prior written consent will be obtained, researcher assures confidentiality and anonymity*
C.8 Ethics clearance status from UCT's Faculty Ethics Research Committee (FREC)	Approved by UCT EIRC: Yes ■ With amendments: Yes ☐ No ■ (a) Attach copy of your ethics approval. Attached: UWC/Ref 15/2/24 of 13 March 2016 (b) State date and reference no. of ethics approval: Date: UCT 30/03/2016 (email) UCT Ref. No - Nil / Faculty: Science Faculty, Approved by: Professor Tim Hoffman; Ms Shari Days.

SECTION D: APPLICANT/S APPROVAL STATUS FOR ACCESS TO STUDENTS FOR RESEARCH PURPOSE

(To be completed by the UCT - ED, DSA or Nominee)

D.1 APPROVAL STATUS	Approved / With Terms / Not	* Conditional approval with terms	Applicant/s Ref. No.:
	(i) Approved ■ ~~(ii) With terms~~ ~~(iii) Not approved~~	(a) Access to students for this research study must only be undertaken <u>after</u> written ethics approval has been obtained. (b) In event any ethics conditions are attached, these must be complied with <u>before</u> access to students.	3008010/ Ms Germaine Kamleu

D.2 APPROVED BY:	Designation	Name	Signature	Date of Approval
	Executive Director, Student Affairs	*Dr Moonira Khan*		*31 March 2016*

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Appendix 3: UWC Ethics clearance letter

OFFICE OF THE DEAN
DEPARTMENT OF RESEARCH DEVELOPMENT

UNIVERSITY *of the* WESTERN CAPE

13 March 2015

To Whom It May Concern

I hereby certify that the Senate Research Committee of the University of the Western Cape approved the methodology and ethics of the following research project by:
Prof L Holtman & Ms G Kamleu (School of Public Health)

Research Project:	An analytical model of assessing the knowledge of statistical procedures amongst postgraduate students in a Higher Education Environment.
Registration no:	15/2/24

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Private Bag X17, Bellville 7535, South Africa
T: +27 21 959 2988/2948 . F: +27 21 959 3170
E: pjosias@uwc.ac.za
www.uwc.ac.za

A place of quality,
a place to grow, from hope
to action through knowledge

Appendix 4: Request for participation in Quantitative phase of research study letter

Dear postgraduate student,

I am Germaine Kamleu, a PhD student in the Department of Mathematics at the University of the Western Cape. Currently, I am conducting a research study to measure the personal self-efficacy (ability) to understand/interpret statistical procedures of postgraduate students as they busy completing statistical tasks with their academic research.

A questionnaire is designed to gather information for a quantitative study. The questionnaire includes demographical data and statistics anxiety, survey attitudes towards statistics, multidimensional scale of perceived social support, and self-efficacy to learn statistics. Self-efficacy beliefs are those beliefs you have about your confidence in your ability to complete specific tasks. For example: "I am confident that I can select the appropriate statistical procedure when estimating validity".

Participation in this study will help you to gain a better understanding of your personal ability of applying statistical procedures. All the data will be kept strictly confidential. You are allowed to withdraw at any time.

Your inputs will be highly valued and appreciated. Kindly contact me if you need further information without any hesitation.

Thank you.

Germaine Kamleu
germainekam@gmail.com
cellphone: 0781239860

Appendix 5: Information sheet for participants

"An analytical model of assessing the knowledge of statistical procedures amongst postgraduate students in a Higher Educational Environment"

Date…………………..

Dear […...participant's Name…….]

PURPOSE OF THE LETTER: This letter is an invitation to consider participating in a study we are conducting to develop a practical model to measure the level of understanding and interpretation of postgraduate students in applying statistical procedures in their academic research. This study will enable the researcher to determine the factors that significantly predict student's ability to understand/interpret statistical procedures. The investigation of these factors resulting from this exploration will allow the development of strategies to improve statistical learning. You are one of these individuals.

PROCEDURES FOR PARTICIPATION IN THIS STUDY: Participation is voluntary. It will involve filling in of questionnaires and participating in semi-structured interviews. Permission will be sought before each recording of the interview sessions. The interviews will occur in a mutually agreed upon location and will take about 45mins. With your permission, the interviews will be audio recorded to facilitate collection of information and later transcribed for analysis. We will send a copy of the transcript to give you an opportunity to confirm the accuracy of our conversation and to add or clarify any points that you wish, sometimes after the interview sessions.

POTENTIAL RISKS THE RIGHT TO WITHDRAW OR TO REMAIN IN THE PROJECT: You may decline to answer any of the interview questions and also withdraw from this study at any time.

POTENTIAL BENEFITS TO THE HIGHER EDUCATION SECTOR: The proposed model of this study will be a replicable statistical evaluation learning process that can be applied to measure the effectiveness and use statistical skills to answer questions related to the real world problems. The potential contribution of this study is to explore the incoming student profile and easily identify the level of understanding and interpretation of statistical procedures.

REMUNERATION FOR PARTICIPATION: There will no remuneration for participating in this project.

CONFIDENTIALITY: All information you provide is considered entirely confidential. Your name will not appear in any report resulting from this study. There are no known or anticipated risks to you as a participant in this study. You are free to withdraw from the study at any time. Consent to participate will be recorded by filling of the signed consent form.

If you have any future questions regarding this study, use the contact details provided below:

Supervisor:

Prof Lorna Holtman
Division of postgraduate studies
University of the Western Cape
Bellville 7535
Tel: 27 21 959 2451/3920
Email: lholtman@uwc.ac.za

Co-supervisor:

DR Bingwen Yan
Division of postgraduate studies
Cape Peninsula University Technology
Symphony Way, Bellville South Industrial, Bellville 7530
Tel: +27 (0)21 460 3911
Email: yanb@cput.ac.za

We look forward to speaking with you. Thank you in advance for your assistance in this project.

Appendix 6: Quantitative Instrument

PART ONE: BACKGROUND AND STARS

SECTION A: BACKGROUND INFORMATION

Please tick in one box below accordingly

A1. Gender

1	Male
2	Female

A2. Date of birth

Date	Month	Year

Approximated age in years

A3. Marital status

1	Single
2	Married
3	Divorced
4	Widow
5	Living together

A4. Ethnic groups

1	African
2	Coloured
3	Indian
4	White

A5. Post-graduate programme

1	Master's
2	PhD
3	Post-doctorate

A6. Student status

1	South African
2	African
3	Non-African

A7. Academic institutions

1	UWC
2	CPUT
3	Others

A8. Type of study

1	Full time
2	Part time

Section B: Experiences in learning research methodology

For all questions on this section, please indicate the appropriate number that best describes your experience.

Very bad	Bad	Average	Good	Excellent
1	2	3	4	5

No	Items	1	2	3	4	5
1	How good at research methodology are you?					
2	How well did you do in your research methodology course?					
3	How confident are you in applying statistical procedures?					
4	In your prospective career, how good/bad do you expect yourself in using statistics?					
5	How did you find your skills in research methods during your current study?					
6	In your opinion, how do you rate the impact of statistical procedures in your current study?					

SECTION C: STARS (Statistics anxiety rating scale)

For all questions on this section, please indicate the extent to which you agree or disagree with each statement.

No Anxiety= 1, Low Anxiety=2, Moderate Anxiety=3, High Anxiety=4, Very high Anxiety=5

No	1. Situations that are commonly associated with statistical anxiety	1	2	3	4	5
1	Studying for an examination in a statistics course					
2	Interpreting the meaning of a table in a journal article					
3	Asking my statistics teacher for help with material I do not understand					
4	Doing the homework for a statistics course					
5	Making an objective decision based on empirical data					
6	Reading a journal article that includes some statistical analyses					
7	Deciding which analysis is appropriate for my research project					
8	Writing an examination for a statistics course					
9	Reading automobile ads which include numbers regarding vehicle performance					
10	Walking into the classroom to take a statistics test					
11	Interpreting the meaning of a p-value					
12	Entering data into a software program					
13	Finding that I obtained a different answer to a statistical problem than another student					
14	Determining whether to reject or fail to reject the null hypothesis					
15	Waking up the morning of a statistics test					
16	Asking one of your professors for help interpreting the output from a statistical software program					
17	Trying to understand the odds of winning a lottery					
18	Observing another student reading statistical software output for their research					
19	Asking others in the computer lab for help in understanding statistical output					
20	Trying to understand the statistical analyses reported in a journal article					
21	Enrolling in a statistics course					
22	Going over a final exam in statistics after it has been graded					
23	Asking a fellow student for help in understanding statistical output					

No Anxiety= 1, Low Anxiety=2, Moderate Anxiety=3, High Anxiety=4, Very high Anxiety=5

No	2. Statements related to statistics	1	2	3	4	5
24	Since I am by nature a subjective person, the objectivity of statistics is inappropriate for me					
25	I haven't had math for a long time. I know I'll have problems getting through statistics					
26	I wonder why I have to do all these things in statistics when in actual life I will never use them					
27	Statistics is worthless to me since it is empirical and my area of specialization is more philosophical					
28	Statistics takes more time than it is worth					
29	I feel statistics is a waste of time					
30	Statistics teachers are so abstract they seem inhuman					
31	I can't even understand seventh- and eighth- grade math; how can I possibly do statistics?					
32	Most statistics teachers are not human					
33	I lived this long without knowing statistics, why should I learn it now?					
34	Since I have never enjoyed math I do not see how I will enjoy statistics					
35	I do not want to learn to like statistics					
36	Statistics is for people who have a natural leaning toward math					
37	Statistics is a pain I could do without					
38	I do not have enough brains to get through statistics					
39	I could enjoy statistics if it were not so mathematical					
40	I wish the statistics requirement would be removed from my academic program					
41	I do not understand why someone in my field needs statistics					
42	I don’t see why I have to cutter up my head with statistics; It has no significance to my life work					
43	Statistics teachers speak a different language					
44	Statisticians are more number oriented than they are people oriented					
45	I can’t tell you why, but I just don’t like statistics					
46	Results of statistical analyses are not fit for human consumption					
47	Statistics isn’t really bad, it’s just too mathematical					
48	Affective skills are so important in my profession that I don’t want to clutter my thinking with something as cognitive as statistics					
49	I’m never going to use statistics so why should I have to take it?					
50	Statistics teachers communicate in a manner that makes it difficult to logically follow them					
51	I’m too slow in my thinking to get through statistics					

PART TWO: SATS (Survey Attitudes toward Statistics)

1. Reversing the responses to the negatively worded items indicated with an asterisk* (1 becomes 7, 2 becomes 6, etc.),
2. Summing the item responses within each component, and
3. Dividing by the number of items within each component.

The possible range of scores for each component is between 1 and 7. Using the 7-point response scale, higher scores then correspond to more positive attitudes.

No	1. Affect – students' feelings concerning statistics	1	2	3	4	5	6	7
1	I will like statistics.							
2	I will feel insecure when I have to do statistics problems.							
3	I will get frustrated going over statistics tests in class.							
4	I will be under stress during statistics class.							
5	I will enjoy taking statistics courses.							
6	I am scared by statistics.							
	2. Cognitive Competence – students' attitudes about their intellectual knowledge and skills when applied to statistics							
7	I will have trouble understanding statistics because of how I think.							
8	I will have no idea of what's going on in this statistics course.							
9	I will make a lot of math errors in statistics.							
10	I can learn statistics.							
11	I will understand statistics equations.							
12	I will find it difficult to understand statistical concepts.							
	3. Value – students' attitudes about the usefulness, relevance, and worth of statistics in personal and professional life							
13	Statistics is worthless.							
14	Statistics should be a required part of my professional training.							
15	Statistical skills will make me more employable.							
16	Statistics is not useful to the typical professional.							
17	Statistical thinking is not applicable in my life outside my job.							
18	I use statistics in my everyday life.							
19	Statistics conclusions are rarely presented in everyday life.							
20	I will have no application for statistics in my profession.							
21	Statistics is irrelevant in my life.							
	4. Difficulty – students' attitudes about the difficulty of statistics as a subject							
22	Statistics formulas are easy to understand.							
23	Statistics is a complicated subject.							
24	Statistics is a subject quickly learned by most people.							
25	Learning statistics requires a great deal of discipline.							
26	Statistics involves massive computations.							
27	Statistics is highly technical.							
28	Most people have to learn a new way of thinking to do statistics.							
	5. Interest – students' level of individual interest in statistics							
29	I am interested in being able to communicate statistical information to others.							
30	I am interested in using statistics.							
31	I am interested in understanding statistical information.							
32	I am interested in learning statistics.							
	6. Effort - amount of work the student expends to learn statistics							
33	I plan to complete all of my statistics assignments.							
34	I plan to work hard in my statistics course.							
35	I plan to study hard for every statistics test.							
36	I plan to attend every statistics class session.							

PART THREE: Multidimensional Scale of Perceived Social Support

Instructions: The interest is in how you feel about the following statements. Read each statement carefully. Indicate how you feel about each statement. The items tended to divide into factor groups relating to the source of the social support, namely family (Fam), friends (Fri) or significant other (SO). **Very Strongly Disagree=1, Strongly Disagree=2, Mildly Disagree=3, Neutral=4, Mildly Agree=5, Strongly Agree=6, Very Strongly Agree=7.**

No	Statements	1	2	3	4	5	6	7	
1	There is a special person who is around when I am in need.								SO
2	There is a special person with whom I can share my joys and sorrows.								SO
3	My family really tries to help me.								FAM
4	I get the emotional help and support I need from my family.								FAM
5	I have a special person who is a real source of comfort to me.								SO
6	My friends really try to help me.								FRI
7	I can count on my friends when things go wrong.								FRI
8	I can talk about my problems with my family.								FAM
9	I have friends with whom I can share my joys and sorrows.								FRI
10	There is a special person in my life who cares about my feelings.								SO
11	My family is willing to help me make decisions.								FAM
12	I can talk about my problems with my friends.								FRI

PART FOUR: Self-efficacy to Learn Statistics (SELS)

Please rate your confidence in learning the skills necessary while you're in the post-graduate programme to successfully complete the following tasks.

(1) = **no confidence at all**, (2) = **a little confidence**, (3) = **a fair amount of confidence**, (4) = **much confidence**, (5) = **very much confidence**, (6) = **complete confidence**.

A) Current statistics self-efficacy

For each task, please mark the one response that represents your confidence in your current ability to successfully complete the task (**to solve**).

No	Statements	1	2	3	4	5	6

1	Identify the scale of measurement for a variable						
2	Interpret the probability value (p-value) from a statistical procedure.						
3	Identify if a distribution is skewed when given the values of three measures of central tendency.						
4	Select the correct statistical procedure to be used to answer a research question.						
5	Interpret the results of a statistical procedure in terms of the research question.						
6	Identify the factors that influence power.						
7	Explain what the value of the standard deviation means in terms of the variable being measured.						
8	Distinguish between a type I error and a type II error in hypothesis testing.						
9	Explain what the numeric value of the standard error is measuring.						
10	Distinguish between the objectives of descriptive versus inferential statistical procedures.						
11	Distinguish between the information given by the three measures of central tendency.						
12	Distinguish between a population parameter and a sample statistic.						
13	Identify when the mean, median and mode should be used as a measured of central tendency.						
14	Explain the difference between a sampling distribution and a population distribution.						

B) Self-efficacy to learn statistics

For each task, please mark the one response that represents your confidence in learning the skills necessary in the current programme to successfully complete the task (**to learn**).

No	Statements	1	2	3	4	5	6
1	Identify the scale of measurement for a variable						
2	Interpret the probability value (p-value) from a statistical procedure.						
3	Identify if a distribution is skewed when given the values of three measures of central tendency.						
4	Select the correct statistical procedure to be used to answer a research question.						
5	Interpret the results of a statistical procedure in terms of the research question.						

6	Identify the factors that influence power.						
7	Explain what the value of the standard deviation means in terms of the variable being measured.						
8	Distinguish between a type I error and a type II error in hypothesis testing.						
9	Explain what the numeric value of the standard error is measuring.						
10	Distinguish between the objectives of descriptive versus inferential statistical procedures.						
11	Distinguish between the information given by the three measures of central tendency.						
12	Distinguish between a population parameter and a sample statistic.						
13	Identify when the mean, median and mode should be used as a measured of central tendency.						
14	Explain the difference between a sampling distribution and a population distribution.						

Appendix 7: Qualitative Questionnaire

Participants are asked to rate the importance of each of the 34 topics related to statistics course applied through their post-graduate research in the social and behavioural sciences. A five-point rating scale is used (Essential, Very important, Important, Relatively unimportant, Unnecessary).

Importance of Statistics Topics

No	Topic	Rating*	Code (No.)
1	Descriptive statistics (frequencies, percentages, central tendency, variability)		
2	t-test for independent samples (between subjects)		
3	Pearson's product-moment correlation		
4	t-test for correlated samples (within-subjects)		
5	One-way ANOVA for independent groups		
6	Chi-squared test of association		
7	z statistic		
8	Simple regression		
9	Effect size		
10	Factorial ANOVA		
11	t-test for one sample		
12	Post-hoc tests for comparison of means		
13	Goodness-of-fit chi-squared		
14	Multiple regression		
15	Spearman's rank order correlation		
16	Multiple correlation		
17	ANOVA for repeated measures		
18	Fisher z transformation		
19	One-way analysis of covariance		

No	Topic	Rating*	Code (No.)
20	Partial correlation		
21	Binomial test		
22	Factor analysis		
23	Mann-Whitney U-test		
24	Wilcoxon signed rank test		
25	Sign-test (binomial distribution)		
26	Discriminant analysis		
27	Fisher exact probability test		
28	Semi-partial correlation		
29	MANOVA		
30	Kruskal-Wallis one-way ANOVA for ranked data		
31	Friedman's two-way ANOVA for ranked data		
32	Cluster analysis		
33	Path analysis		
34	Sandler's A statistic		

How did you decide to choose the test? Or on what basis did you choose the test that you have chosen?

Which information in the item alerted you to that choice? What will the test tell you?

Was it difficult to decide? Which information in the item made it difficult?

Did alternative possibilities come to mind? Why were they rejected?

How confident are you about the decision you made?

Please mention any items that you are not familiar with.

Test Items

(1) Item MA: Mathematics Achievement

A researcher investigates whether mathematics achievement in the middle high school years is influenced by whether or not the student is a first-born child, and also whether there is a *gender difference. A random sample of 100 14-year-old students is obtained from four secondary schools located in various socio-economic status areas of a large city, and a standard test of mathematics achievement developed by the Australian Council for Educational Research is administered.*

	Scores on ACER test	
	First-born	**Later-born**
Male	(N=22) 27 42 33 ...	(N=34) 48 17 35 ...
Female	(N=18) 39 43 16 ...	(N=26) 24 13 32 ...

What statistical test(s) could the researcher use to investigate the effect of birth-order and gender on mathematics achievement?

(2) Item DM: Drink Music

Studies have shown that music can affect mood, emotion, task performance, and cognition. It was hypothesised that the tempo of country-western music played in bars was related to the consumption of alcohol. Observers visited three bars featuring recorded country-western music on three Friday nights. They obtained permission to tape record the music and to make observations of patrons at selected tables. When the music began, the rate of sipping an alcoholic beverage was recorded for each patron. The music tapes were analyzed for the tempo (beats per minute) of each song; the mean number of sips during each song was also recorded.

Tempo	Mean number of sips
35	1.150
38	1.150
44	0.400
...	...
112	0.750
118	0.625

(N = 18)

A scatter plot is drawn, and the relationship is found to be linear. What statistical test(s) could be used to determine the strength of the association between tempo and rate of drinking?

From R. E. Kirk (1984), Elementary Statistics (2nd ed.), Monterey, CA: Brooks/Cole Publishing Co., p. 127; based on a paper by P. J. Bach and J. M. Schaefer (1979), The tempo of country music and the rate of drinking in bars. Journal of Studies on Alcohol, 40, 1058-1059.

(3) Item LB: Light Bulbs

The data in the table are said to represent the lifetimes of 300 light bulbs tested to failure.

Light bulb life (hours)	Frequency	Light bulb life (hours)	Frequency
2050-2100	1	1450-1500	29
2000-2050	1	1400-1450	27
1950-2000	2	1350-1400	24
1900-1950	3	1300-1350	20
1850-1900	6	1250-1300	16
1800-1850	8	1200-1250	12
1750-1800	12	1150-1200	7
1700-1750	16	1100-1150	6
1650-1700	21	1050-1100	3
1600-1650	25	1000-1050	2
1550-1600	28	950-1000	2

What statistic(s) could be used to test whether the frequency distribution conforms to a normal distribution?

Source: F. N. David and E. S. Pearson, Elementary Statistical Exercises, Cambridge: Cambridge University Press, cited in R. J. MacG. Dawson (1996), How many light bulbs does it take to generate a data set? The American Statistician, 50(3), 247-249.

(4) Item AB: Aggressive Behaviour

An early-childhood researcher wishes to investigate whether children's observations of aggressive behaviour affect the amount of their own aggressive behaviour. A sample of 21 six-year-old girls was randomly assigned to one of two conditions. The experimental group viewed a TV program containing numerous aggressive acts; the control group viewed a *program without aggressive acts. Afterwards, each girl was observed at play, and the number of aggressive acts counted. A few girls displayed unusually large numbers of aggressive acts, so the researcher converted the frequency counts to ranks, with the smallest number of aggressive acts given the ranking of 1 and the largest number, 21.*

Ranks of children in experimental group	3, 17, 12.5, ..., 19 (N=10)
Ranks of children in control group	8, 2, 1, 10, ..., 5 (N=11)

What statistical test(s) could be used to investigate whether observing aggressive behaviour affects children's aggressive behaviour?

Based on an example in R. E. Kirk (1984), Elementary Statistics (2nd ed.), Monterey CA: Brooks/Cole Publishing Co., p. 403.

(5) Item HT: Homework Time

A mathematics teacher surveys her students to obtain an estimate of the amount of time spent each week doing mathematics homework, and records her students' scores on an end-of-term mathematics test.

Homework (hrs/week)	8	0.5	6	2	3	1.5	...	4	2
Test score	95	45	60	55	60	55	...	85	40

(N = 25)

One student, who reported that he did 2.5 hours of mathematics homework per week, was absent from the test due to illness. What statistical procedure(s) could the teacher use to predict the student's likely test score?

(6) Item CF: Cat Food

A pet-food manufacturer obtains ten pairs of kittens, each pair coming from one litter. In a trial of a new-formula cat-food, one kitten in each pair is fed on a diet of Superkat, the other a diet of Powerpuss. The table shows the gain in weight (in grams) of each kitten after a week.

Kitten pair:	**A**	**B**	**C**	**D**	**...**	**J**
Superkat diet	12	15	22	17	...	8
Powerpuss diet	14	17	21	20	...	11

(N = 10 pairs)

What statistical test(s) are appropriate for investigating whether there is a significant difference between the two types of cat-food?

(7) Item TC: Test Completion

A university lecturer gives an end-of-semester test in which students are allowed as much time as they need to complete it, observes the order in which the 16 students hand in their test papers, and later records the grade awarded to the student.

(HD = High Distinction; D = Distinction; C = Credit; P = Pass; N = Fail)

Student	A	B	C	D	...	O	P
Order of completion	3	5	1	8	...	14	10
Final grade	D	HD	D	C	...	N	P

(N = 16)

What statistical test(s) could be used to investigate whether there is a relationship between order of completion and final result?

(8) Item GB: Gender Balance

In 1710, Dr. John Arbuthnott, the personal physician to Queen Anne, collected birth registration statistics from the City of London dating back over a period of more than twenty years. He observed a definite tendency for the number of male babies born in any one year to exceed the number of females. Imagine that the data were as follows:

Year	Predominant gender
1688	M
1689	F
1690	M
1691	M
1692	F
1693	M
...	...
1709	M

What statistical test(s) could be used to investigate whether the predominance of male births over females in each year was statistically significant?

(Source of background information: L. A. Marascuilo and R. C. Serlin (1988), Statistical Methods for the Social and Behavioral Sciences. New York: W. H. Freeman & Co.) The data are invented.

(9) Item LR: Light Reactions

Twelve students are randomly assigned to three conditions of a perceptual-motor experiment where ambient illumination is the independent variable and subject reaction time is the dependent variable.

Reaction time (seconds)		
Bright light	Medium light	Dim light
1.1, 1.0, 0.8, 1.5	1.4, 1.1, 1.6, 1.9	0.8, 0.7, 1.2, 1.3

How could the hypothesis that ambient light affects reaction time be investigated?

Source: K. C. Clayton (1984), An Introduction to Statistics for Psychology and Education, Columbus, OH: Charles Merrill, p. 197.

(10) Item AA: Arithmetic Achievement

A researcher obtains measures of mental age (X_1) from an IQ scale, reading ability (X_2) from a standard test of reading comprehension, and arithmetic ability (Y) from a standard test of arithmetic achievement for a sample of 40 upper primary school children.

X_1	X_2	Y
9.2	61	126
10.0	47	60
8.0	79	117
7.4	40	96
...	...	...
7.0	55	91

(N = 40)

Another child has a mental age of 11.2 and a reading test score of 63. What statistical technique(s) could the researcher use to predict that child's arithmetic score?

Source: Table 45.1 in L. A. Marascuilo and R. C. Serlin (1988), Statistical Methods for the Social and Behavioral Sciences, New York: W.H. Freeman.

(11) Item RA: Reading Ability

Mr. Kemp, the Grade 3 teacher at Vanstone Primary School, is concerned about the literacy levels of his class and administers a standardised reading test for which the population mean for third-graders is 65.0. His class of 24 students obtains a mean score of 59.7 and a standard deviation of 9.3. What statistical test(s) could he use to determine whether his class is significantly different from the population?

(12) Item SH: Smoking Habits

Tunbridge et al. (1977) report data on smoking and survival obtained from a longitudinal study in an English town:

Relationship between smoking habits and 20-year survival in 1314 women

	Smoker	**Non-smoker**	**Total**
Dead	139	230	369
Alive	443	502	945
Total	582	732	1314

What statistic(s) could be used to test whether there is an association between smoking and survival?

(Note: The data, which are genuine, might seem to suggest that smoking ***increases*** *one's chances of survival. Simple statistical tests are not always the most appropriate ones. The data listed here take no account of the age of the participants, nor do they allow for the fact that all those who had already died from smoking-related illnesses never made it to the start of the 20-year survey!)*

Source: W. M. G. Tunbridge, D. C. Evered, R. Hall, D. R. Appleton, M. Brewis, F. Clark, J. Grimley Evans, E. Young, T. Bird, and P. A. Smith (1977), The spectrum of thyroid disease in a community: The Whickham Survey. Clinical Endocrinology, 7, 481-493, cited in D. R. Appleton, J. M. French, and M. P. J. Vanderpump (1996), Ignoring a covariate: an example of Simpson's Paradox. The American Statistician, 50(4), 340-341.

(13) Item II: Inherited Intelligence

According to one genetic theory, IQ test scores of two brothers ought to show a correlation of 0.50. To test this theory, records of a school district were searched to find the IQ test scores of brothers born within two years of each other; 49 such pairs were found. The correlation between the sets of IQ scores was found to be 0.58.

What statistical test(s) could be used to determine whether the observed correlation differs significantly from the theoretically expected value?

Source: Chapter 24 in L. A. Marascuilo and R. C. Serlin (1988), Statistical Methods for the Social and Behavioral Sciences, New York: W. H. Freeman

(14) Item MU: Menzies University

The Vice-Chancellor of Menzies University successfully introduces a policy in which all first-year students are required to take a one-semester unit in essay-writing. The V-C asks the university's Education Research Unit to compare the performance of students in various faculties of the university. A random sample of 25 students from each faculty is obtained. The head of ERU has access to individual students' prior performance in Year 12 English, and suggests that the comparison should attempt to control for prior differences in ability in English.

Variable X: Student performance at Year 12 English (0-20 scale)

Variable Y: Student performance at first-year Essay-writing subject (0-100 scale)

Arts		**Business**		**Engineering**		**Medicine**		**Etc.**
X	**Y**	**X**	**Y**	**X**	**Y**	X	**Y**	**...**
19	80	14	62	17	75	18	95	...
18	90	15	71	14	83	19	87	...
12	65	12	55	12	53	15	74	...
...	...	...	...	...	...	...	...	...

What statistical method(s) would allow the ERU head to investigate whether there were differences in performance in essay-writing between faculties, after taking into account prior differences in ability in English as measured by the Year 12 results?

(15) Item AE: Alcohol Effects

Twenty members of a local Rotary Club participate in an experiment on the effects of alcohol on reaction time. They are randomly assigned to two groups. Each person in the Alcohol group is given three cans of rum-and-cola to consume over a period of an hour; members in the No-Alcohol group are given identically-labelled cans containing cola mixed with a non-alcoholic rum-flavoured syrup. Each person's reaction time is then measured in a driver-simulation apparatus.

	Reaction time (seconds)
Alcohol group (N=10)	0.37, 0.42, 0.28,..., 0.45

Non-Alcohol group (N=10)	0.29, 0.32, 0.37,..., 0.22

What statistical test(s) could be used to investigate whether alcohol makes a difference to people's reaction time? (Invented data)

(16) Item DV: Drinking Vodka

A group of 63 young adults is divided, on the basis of interview, into daily users and non-users of alcohol. Each member of these two groups is then further randomly allocated to one of three sub-groups and given 0 or 1.5 or 3 ounces of vodka. A motor performance test is then carried out which requires the participant to keep a beam of light focussed on a randomly moving target during a ten-minute period. Time on target is measured. The data are summarised in the table below, and an analysis of variance procedure yields a significant F ratio.

	Nonuser			**User**		
Group	1	2	3	4	5	6
Amount of vodka (ounces)	0	1.5	3	0	1.5	3
Sample size	10	8	9	12	9	15
Mean time (minutes)	8.9	6.4	3.1	9.1	8.8	7.6
Standard deviation	1.6	2.2	2.7	1.4	1.9	2.3

What statistical procedure(s) could be used to investigate whether the difference between the means of any two groups is significant?

Source: Chapter 33 and Table 33.1 in L. A. Marascuilo and R. C. Serlin (1988), Statistical Methods for the Social and Behavioral Sciences, New York: W. H. Freeman.

(17) Item ME: Maze Errors

Twelve students were divided at random into three groups of four people each, and given a complex maze problem which was mounted on a board. They were required to track through the maze with a stylus. An electrical system registered the numbers of errors made. Each participant was given five trials. One group of students was told that maze-solving ability was related to intelligence, a second group that average college students made 20 errors, and the third group that they should make as few errors as possible.

	Student	**Trial 1**	**Trial 2**	**Trial 3**	**Trial 4**	**Trial**
Intelligence group	11	40	39	33	33	20
	12	40	33	...	...	...

	Student	Trial 1	Trial 2	Trial 3	Trial 4	Trial
	...					
	14					
Average 20 group	21					
	...					
	24					
Few-errors group	31					
	...					
	34	...	...	21	23	21

What statistical procedure(s) should be used to investigate whether the number of errors is related to the nature of the information given to each group?

Source: Table 42.6 in L. A. Marascuilo and R. C. Serlin (1988), Statistical Methods for the Social and Behavioral Sciences, New York: W. H. Freeman.

(18) Item SE: Self-Esteem

A psychological researcher is reviewing the literature on the effects of various therapeutic treatments on the self-esteem of troubled young men who have been identified as displaying suicidal tendencies. Treatment A yielded a mean self-esteem score of 54.5, in comparison with a control group that did not receive treatment and scored a mean of 51.3, standard deviation 7.5. In treatment B, the researchers used a completely different measure of self-esteem, and obtained a mean score of 22.4 for the experimental group and 18.1 for the control (standard deviation, 5.2). What method(s) could the literature reviewer use to compare the relative effectiveness of the two treatments?

(19) Item GI: Gross Income

A social scientist obtains a sample of males aged in their thirties, and gathers data on three variables:

X: socio-economic status of their parents (measured on a 7-point scale)

Y: years of formal education (ranging from 10 to 19 years)

Z: current annual gross income in dollars

What statistic(s) could be used to measure the strength of the relationship between income and the combined effect of the other two variables?

Problem suggested by a discussion in D. Freedman, R. Pisani, and R. Purves (1978), Statistics, New York: W. W. Norton, p. 197.

(20) Item YM: Young Mothers

A psychologist studies a sample of young mothers and obtains rating-scale and observational measures on five variables: ***dysphoria*** *(a measure of depression),* ***emotional closeness*** *(to her baby),* ***duration*** *(time spent interacting with the baby),* ***marital conflict****, and* ***husband's psychiatric history****. The psychologist wishes to investigate whether there are any latent variables (i.e., patterns of relationships) underlying these five variables. What method(s) could be employed to search for such patterns?*

Problem suggested by a discussion in B. Everitt and D. Hay (1992). Talking about statistics. A Psychologist's Guide to Design and Analysis, London: Edward Arnold, Ch. 9.

(21) Item RC: Reading Comprehension

A teacher of English administers a reading comprehension test with a range of possible scores of 0-50 to her class. The mean score of the class is 29.5 and the standard deviation is 7.5. She also gives her students an essay to write and marks it on a 0-100 scale. The mean score of the class on the essay is 73 and the standard deviation 12. One of her students, Mary, scores 43 on the reading comprehension test and 86 on the essay. What statistical procedure(s) could the teacher use to decide whether Mary was relatively better at reading comprehension or essay-writing?

Appendix 8: Editorial Certificate

24 July 2018

To whom it may concern

Dear Sir/Madam

RE: Editorial Certificate

This letter serves to prove that the thesis listed below was language edited for proper English, grammar, punctuation, spelling, as well as overall layout and style by myself, publisher/proprietor of Aquarian Publications, a native English speaking editor.

Thesis title

AN ANALYTICAL MODEL FOR ASSESSING
THE KNOWLEDGE OF STATISTICAL PROCEDURES
AMONGST POSTGRADUATE STUDENTS IN A
HIGHER EDUCATIONAL ENVIRONMENT

Author
Germaine Kamleu

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